SACRAMENTO-SAN JOAQUIN DELTA
MASTER RECREATION PLAN

Preliminary Edition

June 1966

EDMUND G. BROWN
Governor
State of California

HUGO FISHER
Administrator
Resources Agency

HUGO FISHER
ADMINISTRATOR

Department of Conservation
Department of Fish and Game
Department of Parks and Recreation
Department of Water Resources
State Reclamation Board
State Water Quality Control Board
State Water Rights Board
Regional Water Pollution Control Boards

EDMUND G. BROWN
GOVERNOR OF CALIFORNIA

OFFICE OF THE ADMINISTRATOR
RESOURCES BUILDING
1416 NINTH STREET

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

June 30, 1966

Honorable Edmund G. Brown
Governor
State Capitol
Sacramento, California

Dear Governor Brown:

Pursuant to Chapter 2094, Statutes of 1963, I am pleased to present the following report outlining a Delta Master Recreation Plan.

Major considerations were given to the recreational aspects of land and waterway use, flood control practices, wildlife management and water resources development, as well as to the immediate requirements of the recreating public.

Noteworthy, are recommendations for a system of Delta aquatic parkways; recommendations for creating wildlife management areas; recommendations for additions to the State Park System; and recommendations for new levee construction and maintenance practices.

The four major departments of this Agency, two of the Agency's Statutory Boards, and three major federal agencies made extensive contributions to this study. In addition, many contributions were made by other State and federal agencies and by local government. Many special interest groups provided advice and assistance. Though not all participants are in complete agreement with every detail of the master plan, they all certainly agree that the Delta's recreational resource cannot be duplicated, is invaluable, and must be preserved and enhanced wherever possible.

Sincerely yours,

Hugo Fisher

Administrator of Resources

Enclosure

HUGO FISHER
ADMINISTRATOR

Department of Conservation
Department of Fish and Game
Department of Parks and Recreation
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THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

June 30, 1966

Honorable Glen M. Anderson, President
California State Senate
State Capitol
Sacramento, California

Dear Governor Anderson:

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THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

June 30, 1966

Honorable Jesse M. Unruh, Speaker
California State Assembly
State Capitol
Sacramento, California

Dear Mr. Speaker:

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Sincerely yours,

Hugo Fisher

Administrator of Resources

Enclosure

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CHAPTER 2094, Statutes of 1963

An act to provide for a study of the Sacramento-San Joaquin Delta, and making an appropriation therefor.

The people of the State of California do enact as follows:

Section 1. The Administrator of the Resources Agency, in collaboration with the State Office of Planning, shall undertake a study for purposes of developing a comprehensive master recreation plan for the Sacramento-San Joaquin Delta and along the Sacramento River. Attention shall be given to solving the levee vegetation problem as it affects flood control, aesthetic beauty and wildlife populations. Consideration shall be given to delineating areas within the Sacramento-San Joaquin Delta and along the Sacramento River which offer substantial opportunity for coordinated recreational planning between federal, state, and local planning, flood control, water development and conservation groups. In addition, consideration shall be given to methods of implementing the master recreation plan, with special consideration being given to recreational use zoning, land acquisition, construction of recreational facilities, including roads and bridges, and protection or planning of vegetation on levees and waterside berms. Said study shall include an estimate of the cost involved in the implementation of said master recreation plan together with a determination of alternative methods of financing and a basis for allocating federal, state, and local responsibility. Particular attention shall be given to determining an equitable sharing formula for construction as well as operation and maintenance costs of the Sacramento River Bank Protection Project among state and local agencies based on the benefits and detriments allocable to both on behalf of flood control and recreation beneficiaries or based upon any other equitable apportionment. The Administrator of the Resources Agency shall submit the results of such study to the Legislature by the first Monday of February, 1966.

Section 2. The sum of forty thousand dollars ($40,000) is hereby appropriated from the General Fund to the Administrator of the Resources Agency for expenditure in carrying out the study which is provided for in Section 1 of this act.

(Introduced as Senate Bill 1630. Authored by Senators Rodda, Short and Gibson)

STATE OF CALIFORNIA
THE RESOURCES AGENCY

EDMUND G. BROWN, Governor
HUGO FISHER, Administrator, The Resources Agency

This report was prepared under the direction of the Resources Agency Administrator

Assistance with various phases of this investigation was given by the Resources Agency Interdepartmental Committee for Delta Recreation Planning consisting of

Parent Committee

DeWitt Nelson, Chairman	Director, Dept. of Conservation
Harold W. Walt	Deputy Director, Dept. of Finance
Fred L. Jones	Director, Dept. of Parks and Recreation
Colonel Albert E. McCollam	General Manager, State Reclamation Board
Walter T. Shannon	Director, Dept. of Fish and Game
William E. Warne	Director, Dept. of Water Resources
Raymond J. Nesbit	Executive Officer, Wildlife Conservation Board
John Erreca	Director, Department of Public Works
Colonel Robert E. Mathe	U.S. Army Corps of Engineers (ex-officio)
Robert G. Pafford, Jr.	U.S. Bureau of Reclamation (ex-officio)
Frank E. Sylvester	U.S. Bureau of Outdoor Recreation (ex-officio)
William A. Toomey, Executive Officer	The Resources Agency
Hugo Fisher, Advisor	Administrator of Resources

Staff Committee

William A. Toomey, Chairman	The Resources Agency
Sven Anderson	Div. of Soil Conservation
Larry Davis	Department of Water Resources
William Griffith	Department of Fish and Game
Elvin Curtis	Div. of Small Craft Harbors
Ed Dwyer	Div. of Beaches and Parks
Edward Kress	Div. of Beaches and Parks
Everet Gale	Div. of Recreation
Howard Sullivan	State Reclamation Board
Alex Bigler	State Office of Planning
Chester M. Hart	Wildlife Conservation Board
Donald Van Riper	Division of Highways
Robert F. Angle	U.S. Bureau of Outdoor Recreation
Bill Manderscheid	U.S. Bureau of Reclamation
George Weddell	U.S. Army Corps of Engineers

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FOREWORD

The master plan presented in this report is the result of a joint effort by many agencies and individuals representing many different, but related, disciplines. As planning progressed and discussions were held, many new concepts were put forth and several of these concepts became the moving force for present on-going programs.

The Delta Meadows State Park, formulated as a part of this study, is now authorized and will soon become a physical reality. Old River Islands Project also recommended in this report for inclusion in the State Park System was approved by the Park Commission and is included in the current State Budget before the Legislature. Plans are currently being formulated jointly by the U.S. Army Corps of Engineers and the State Resources Agency whereby levee beautification will be incorporated into segments of current levee reconstruction projects. This latter endeavor is being made on an experimental basis but a definite start has been made using concepts developed in this study.

A summary brochure to this preliminary edition is being prepared and will be available for wide distribution shortly. Detailed technical documents covering aspects relating to levee construction and maintenance, fish and wildlife and State Park and Recreation Areas will also be made available to those interested.

SUMMARY OF RECOMMENDATIONS

Considering the magnitude of the present and projected future recreational use of the Delta, the invaluable importance of its fishing, wildlife, scenic and open-space resources and the inevitable demands which will occur from commercialization, urbanization and all other demands of California's expanding economy, it is imperative that this master plan be adopted in concept by all components of government as well as commercial and private interests. Further, it is vital to the Delta's outdoor recreation potential that all elements of this plan should be considered integral features of the total plan, just as the areas to be protected and enhanced by each element have been considered to be integral parts of the Delta in its entirety.

Perpetuating this recreation master plan is of prime importance. Too often, plans of this nature are forgotten after initial presentation and programs continue on unilaterally or are completely shelved. California can ill afford this happening to such a significant resource. When the resource is gone, it is gone. It will not come back of its own accord.

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The State must continue to assist federal and local public and private entities by helping to coordinate the necessary planning for preservation of the Delta's natural beauty and its open spaces. State Government must also implement the recommended State action programs.

It is recommended that the Legislature direct the Resources Agency Administrator (by concurrent resolution) to coordinate the implementation of this master plan. Implementation will include continual exchange of information and ideas, necessary acquisition and development and, most importantly, updating the master plan as the public's needs require. The Resources Agency Administrator should be required to review with all affected State, federal and local entities, the adequacy and status of programs and policies in terms of sound and practical resources management. This review should occur at least twice yearly. The Resources Agency Administrator should report to the Governor and the Legislature every two years on the current status of the Delta's recreational development and include with the report any recommendation for new legislation and/or policies. The first report should be submitted in 1968.

The major recommendations of this master plan are summarized as follows.

Auto and Aquatic Parkways

It is recommended that the Department of Parks

and Recreation receive authority and funds to develop a plan for a Sacramento River Parkway and a Cosumnes River Parkway under the provisions set forth in the California Parkway Act (Chapter 1626, Statutes of 1965).

The California Parkway Act should be amended to provide for an aquatic parkway system or a new act adopted by the Legislature which would permit establishment of an Aquatic Parkway System and following such authorization the Department of Parks and Recreation should be given the authority and funds to develop plans for aquatic parkways along the San Joaquin, Mokelumne and Old Rivers.

The Department of Parks and Recreation should commence the above programs as soon as authorization can be granted and develop a staged plan in collaboration with other appropriate State, federal and local agencies.

Waterway Use Plan

The broad concepts of water use classifications presented here should be formally recognized and adopted by the State of California, the Federal Government and the Delta area counties. Several methods of implementation are readily available through exercise of present authorities at all levels of government.

It is important that future recreational development in the Delta take cognizance of the need for orderly waterway use.

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Future action programs by governmental organizations can offer major impetus to a waterway use plan by simply following it.

Local government can assist by adopting compatable zoning ordinances on lands adjacent to the waterways.

The State Reclamation Board and the U.S. Army Corps of Engineers should be enabled to exercise more discretion in granting levee and navigational encroachment permits as appropriate to their regulatory powers.

The State Department of Parks and Recreation should designate the use of the Delta's waterways in accordance with the broad classifications recommended here by providing adequate channel markings. This can best be carried out through the Division of Small Craft Harbors in collaboration with other affected State and federal agencies and with local planning and law enforcement officials.

Levee Construction and Maintenance

It should be the policy of the State of California that all flood control project levees and berms of the Sacramento-San Joaquin Rivers Delta which are built wholly or in part with State funds and where the State is required to furnish lands or rights of way that such lands be acquired by the State in fee.

Vegetation should be re-established on all flood control project levees at the time of construction or rehabilitation.

Maintenance of all State-owned levees in the Delta should be performed by a single agency of the State and new methods of maintenance should be adopted as described in this report.

The State agency to perform the levee maintenance in the Delta should be the State Reclamation Board.

Water Resources and Related Development

The State Department of Water Resources and the U.S. Bureau of Reclamation should appoint a Peripheral Canal recreation advisory group to assist in carrying out advanced planning programs and to assist in developing design concepts. This group should include representatives from federal, State and local governmental organizations having interests in recreation and fish and wildlife. Peripheral Canal recreation facilities should be planned for and provided in such a manner as to be consistent with this master plan.

Operation and maintenance of the Peripheral Canal should be the responsibility of the State of California.

The Clifton Court Forebay, to be constructed as a State facility, offers opportunities for enhancing the recreational potential of the southern Delta, and advanced planning programs for recreation at this forebay should be continued jointly by the State Department of Parks and Recreation and Water Resources according to the provisions of the Davis-Dolwig Act.

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Delta State Parks or Recreation Areas

In addition to the Delta Meadows Project, it is recommended that the Cosumnes River Project, the additions to Frank's Tract State Recreation Area, and the Old River Island Project, as described in this report, be incorporated into the State Park System.

The areas recommended above should be acquired forthwith by the Department of Parks and Recreation and the detailed planning and construction of minimum developments should proceed as rapidly as possible. Acquisition, detailed planning and minimum developments should be funded by the State Beach, Park, Recreational and Historical Facilities Bond Act of 1964 or by special appropriations of the State Legislature.

Wildlife Resources Development

Public ownership is recommended for those areas designated in this report as Wildlife Preservation and Management Areas.

The State Department of Fish and Game should immediately commence an action program for purposes of implementing the applicable features of the plan presented in this report. Applications for federal funds available through the Land and Water Conservation Fund and the Title VII Open Space Grants should be prepared and submitted and the department should detail and implement procedures that will be required for the development and management of these areas.

Preservation of Non-Leveed Channel Islands

Nearly all of the Non-Leveed Channel Islands of the Delta should be secured in public ownership immediately. These lands, comprising 13,000 acres, are invaluable to the Delta's scenic, wildlife and recreational resources.

An action program should be undertaken immediately by the Department of Parks and Recreation and the Department of Fish and Game, in collaboration with the Division of State Lands, pursuant to the plan presented in this report. This program should delineate those lands having first priority for acquisition and preservation or development during a first five-year program. All remaining lands not acquired during the first five years should be secured no later than ten years from the date of this report.

It is recommended that Land and Water Conservation Fund and Title VII Open Space Grants be utilized for this purpose as well as funds administered by the Wildlife Conservation Board.

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CHAPTER I. INTRODUCTION

Approximately 700 miles of meandering inland waterways constitute a vast region of Central California known as the Sacramento-San Joaquin Rivers Delta. Within this area of 738,000 acres are innumerable governmental entities including portions of seven California counties and many communities of varying sizes. The Sacramento-San Joaquin Delta, as defined in Section 12220 of the Water Code is shown on Plate 1, entitled "Area of Investigation".

Highly advanced economic development has occurred throughout the Delta region in four primary categories, these being agriculture, heavy industry, commercial navigation and recreation. The Delta region also has a great wealth of natural resources including scenic beauty, water, natural gas, highly-productive organic soils and a unique and highly valued representation of fish and wildlife resources.

The present recreational use of the Delta amounts to approximately three million recreation days annually and is occurring in spite of almost total absence of public recreation facilities. This use is principally water orientated and includes fishing, cruising, water skiing and hunting. Future recreation demand for the Delta, based on predicted trends in population, leisure time and mobility, is estimated to be approximately 195 million visitor-days annually by the year 2020. This is a predicted increase of 6,500 percent!

Numerous problems affecting the conservation and utilization of the Delta's unique resources now exist and as

the need for the out-of-doors increases, the conflicts between recreational use and the Delta's other activities are bound to multiply in the absence of long-range coordinated planning. A prime example are the problems relating to the removal of levee vegetation, long deemed necessary for adequate flood control purposes. Loss of this vegetation, however, destroys unique natural beauty and wildlife habitat. Another example is the eminent construction of water transfer facilities in the delta which may result in major changes in the Delta's environment.

Numerous federal, state and local agencies are presently involved in many inter-related Delta studies. Nearly every component of the Resources Agency, as an example, has functions underway which concern the Delta. Their functions include investigation, regulatory and construction activities. Nearly all of these activities directly or indirectly affect recreation. Program coordination requires a major effort by all in an attempt to dovetail activities and prevent duplication.

The need for state leadership in the preparation of a comprehensive Delta master recreation plan is apparent when the importance and extent of the area and the number of governmental units involved is considered. The urgency of this need is demonstrated by the present and predicted demands for recreation.

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Origin of the Study

During the year 1961, public controversy over levee maintenance practices made those in State Government aware of the conflicting problems associated with Delta recreation. Recognizing these problems, the Legislature enacted Chapter 324, Statutes of 1961, (AB 139), authorizing the Sacramento River and Delta Recreation Study. One of the major recommendations resulting from that study was that the Resources Agency give consideration to developing a master recreation plan for the Delta. The Legislature, during the 1963 session, adopted Chapter 2094, Statutes of 1963 (SB 1630) authorizing the Resources Agency Administrator to prepare a comprehensive Delta master recreation plan.

Conduct of the Study

The Administrator of the Resources Agency was responsible for the conduct of the study. This responsibility included overall coordination, resolution of planning conflicts, adoption of the final master plan, and presentation of the plan to the Legislature. Assistance was provided by an interdepartmental committee appointed by the Administrator of the Resources Agency which was organized as follows:

Department of Conservation
Department of Water Resources
Department of Parks and Recreation
Department of Fish and Game
The State Reclamation Board
The Wildlife Conservation Board
Department of Finance
Division of Highways
U. S. Bureau of Reclamation (ex-officio)
U. S. Army Corps of Engineers (ex-officio)
U. S. Bureau of Outdoor Recreation (ex-officio)

Each contributed to the study in those areas appropriate to departmental responsibilities. Participation was provided by these organizations on a parent and staff committee. Local government and interested citizenry were called upon for assistance to insure that local planning and the needs of organizations concerned with promoting conservation, recreation and fish and wildlife enhancement were recognized.

Aspects of this master plan relating to levee construction and maintenance were developed and prepared by the consulting engineering firm of Bradberry Associates, Incorporated of Los Altos, California.

Objective of the Master Plan

Simply stated, the purpose of this master recreation plan will be to serve as a comprehensive guide for preserving and developing the Delta's scenic, wildlife and recreational resources. Consideration was given to all areas exhibiting opportunity for coordinated recreational planning between federal, state and local planning, flood control, water development and conservation groups. The completed master plan includes considerations necessary for recreational zoning; land use and acquisition; design, layout and

construction of recreational facilities; improvement of recreational access; enhancement of aesthetic beauty; and enhancement of fish and wildlife values. The master plan also includes recommendations for action programs to implement the plan, cost estimates for these programs, and delineates the basis by which financing can be allocated between the various federal, state and local responsibilities. Finally, the formulation of this master plan included considerations for the relationship of Delta recreation to the overall recreation potential of California and, consequently, is consistent with the State Water Plan, the California Fish and Wildlife Plan, the State Park System, the State Development Plan, the California Public Outdoor Recreation Plan, the California Boating Plan and all proposed and adopted Delta County Plans.

CHAPTER II. THE SACRAMENTO-SAN JOAQUIN DELTA

The waterways, open space, and natural wilderness of the Sacramento-San Joaquin Delta provide one of the most important recreation areas in California. Combined with the great rivers of the Sacramento-San Joaquin Valley and San Francisco Bay, the Delta creates an inland aquatic complex that rivals any other anywhere.

Geography and Topography

The Delta is located just east of the eastern extremities of the San Francisco Bay system. The waters of the Delta have formed a network of channels totaling nearly 700 miles in length. The Delta waters and lands occupy nearly 1,150 square miles in Sacramento, San Joaquin, Contra Costa, Solano and Yolo Counties.

The meets and bounds of the Delta are defined in Section 12220 of the California Water Code. It is generally described as the lowlands around the confluence of the Sacramento and San Joaquin River systems which lie between elevations of 5 feet above and 20 feet below sea level. A few sandy and silty mounds of natural origin over 5 feet elevation exist in the basin at several locations. "Spoil" from dredging operations in channels down through the years has also built up some areas considerably higher in elevation than the average level of the lowlands.

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Geology

Geologically, the Delta is associated with the development of the present San Francisco Bay, San Pablo and Suisun Bays. The formation of the region is very recent compared to a total earth history of rock formation of over 12 million years ago. The Bay area land formations date back to the Pliocene period of the Cenazaic which is the present geological era. The present bay probably took shape within the last one-half million years.

The existing land forms of the Delta were created during very recent geological times by the Sacramento and San Joaquin Rivers. As the rivers flowed down from the mountains surrounding the great Central Valley to meet the Pacific Ocean at San Francisco Bay, they deposited alluvium as they met the tides of the Pacific Ocean. The soils are composed of sand, silt and loamy clay alluvium, peat and organic sediments; the result of centuries of natural soil deposition and decomposition of marshland vegetation.

Soils

The Delta area constitutes one of the more distinct elements in the complex physiographic and soil patterns of California. Its peculiar pedologic, physiographic, agronomic and other features make it definitely unique. The soils of the Delta can be placed into two general categories: organic and mineral.

The soils within each category have common characteristics and bear close relationships to one another, even though they differ significantly from other soils in California.

Most organic soils are derived from the water-saturated layer of tule-reed peat. The accumulation of plant remains covers approximately 415,000 acres from the junction of the Sacramento and San Joaquin Rivers, northward, eastward, and southward. The underlying material is a light gray mineral sediment. The peat ranges in depth from 2 feet along the eastern margin to about 40 feet at the western tip and averages about 18 feet.

The mineral soils are developed over transported materials of mixed mineralogical composition. These have developed profiles of moderately definite pedacallic tendency. Their color ranges from brown to dark gray. With a few exceptions, they occupy flat basin-like areas on the lower slopes of the surrounding valley plain. They are subject to poor drainage and concentration of salts. These bodies can best be described as the transitional zone between the well-drained mineral soils of the upper valley and the water-logged organic soils of the island country along the lower courses of the Sacramento and San Joaquin Rivers.

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Climate

Generally, the Sacramento-San Joaquin Delta area has hot rainless summers and cool moist winters. It is referred to as a Mediterranean type of climate. Cool ocean breezes entering the Delta area through the Carquinez Strait, very strong at times in the western portion, temper the extreme heat conditions which occur in other parts of the Central Valley. Prevailing winds over most of the Delta are from a westerly direction. The mean temperature is approximately 60°F with 45°F to 50°F from December to March and about 75 F plus from June to September.

The annual rainfall over the Delta varies from about 18 inches in the eastern and central parts to about 12 inches in the southern part. More than 50 percent of the percipitation falls during the winter. Ocean and local fogs coupled with the extensive areas of open water produce a fairly high atmospheric humidity over the area even during the summer months. More specific information relative to expected monthly temperature and percipitation amounts can be obtained from the United States Weather Bureau which maintains stations around the perimeter of the Delta.

History

Before white men came, the Delta was a great island wilderness. Even as late as 1870, Father Narcisco Duran of

Mission San Jose described the area as being "like a park because of the verdure and luxuriance of its groves of trees". Huge Valley Oaks provided the basic acorn meal required as food by the natives, vast thickets of blackberries provided his dessert....

Consequently, the area was frequented by these people and later by white hunters and trappers bent upon obtaining food and furs. Evidence of the latter is reflected by the name French Camp some 4 miles south of Stockton where French trappers rendezvoused around 1832. This was the terminus of the Oregon Trail used by these trappers from 1832 to 1845.

In the fall of 1841, Charles M. Webber stopped at French Camp while on his way into California with the Bidwell-Bartleson party. Much impressed, he returned with William Guinac in 1844 to the Rancho del Campo de Los Franceses grant and started the colonization of the San Joaquin Valley. Later, he was to lay out the town of Stockton which became the hub of miners' supplies for the Southern Mines during the gold rush. By 1850, 28 steamboats and a host of sailing vessels were involved in trade on the rivers. Soon channel clogging by alluvial deposits and debris from upstream mining operations forced deeper draft vessels to give way to shallow-draft, flat-bottom boats and scows. Attracted by markets for farm goods, men

were drawn from the mines to farms on the Delta. Hundreds of acres of land were cleared, often by fire, and natural vegetation and wildlife began its slow but steady retreat.

Townships and miners' settlements began to appear: The village of Old Liberty at Davis Crossing on the Mokelumne River to which S. H. Davis ran his sloop, the Mary Bowers in 1856; Mokelumne City, where he established a boat building business and lumber yard; Linden, camped at earlier by John C. Fremont, 1844; Marsh's stone house on today's Marsh Creek Road in Contra Costa County; Thornton; Walnut Grove; and finally the town of Locke, an interesting Chinese locality founded in the early years of this century. Its false-front buildings with their overhead balconies and shaded sidewalks, conveys an atmosphere of early river days and attests to the contributions made by the Chinese whose work on the levees helped to reclaim large areas of submerged land for farm use.

The combination of fertile soils and unlimited water supply led to vast reclamation projects and development of an outstanding agricultural industry.

The first levees were constructed by Chinese coolies with hand tools, pails, and wheelbarrows; it is believed that the first efforts toward prevention of inundation by using levees was made along the southerly side of Grand Island in 1852. These first efforts were followed by higher and more

substantial levees constructed by clam shell dredges. As the levees were built, the island basins within their confines were pumped dry to expose the fertile soil. The dredging operations left numerous islands and tracts of land ranging from 2,000 to nearly 25,000 acres surrounded by waterways. The principal crops produced were asparagus, potatoes, celery, tomatoes, and varied so-called truck crops. Recently, more emphasis has been placed on grains, hay, and milo, however, the Delta still produces most of the nation's canned asparagus.

As improvements grew and there was a greater need for flood protection, know-how and better machines led to a new method of levee construction. Levees were set back from the water's edge as far as the dredge boom would allow leaving a strip of lowland or old lower levees in front. These strips were called "berms". Most levees were constructed of indigenous soils taken from the existing channel areas. The numerous "channel islands" or "spoil islands" within the channels resulted from original land which was not protected by levees or was not dug out by dredges during levee construction. In many cases, these areas simply could not be reached due to the "boom" limitations of the dredgers. In later years some of these islands were built up by spoil from channel deepening.

On the relatively untouched "channel islands" and original land is found the only resemblance of what the Delta used to be.

Even though the Delta as a whole has changed considerably in appearance, these natural and seminatural areas provide a parcel of the past for the enjoyment by people today. In several places, one requires only Indian shelters and a few Indians to set the scene; in others, only the blunt prow of the river boat is needed to re-create the picture of earlier days; but, Mokelumne City is a ghost, as is Marsh, Webber, Davis and Locke. Their story is an important chapter in the book of pioneers who came and influenced the destiny of California's colorful development.

Landscape and Cover

When white man first came to the Delta area, it was largely a vast tule marsh. Within this marsh the larger streams and hundreds of minor waterways divided the Delta into "scores of interfluvial units or islands". The major waterways naturally built up ridges along the channels, but these ridges were overflowed during flood periods. From the alluvial rims, the surface of each island usually dropped saucer-like, toward the interior. The central parts almost everywhere were below sea level. The denser stands of bulrush, or tule (Scirpus lacustris) grew in the central part of the islands where the surface was covered with shallow water most of the year. On the natural ridges the tules were replaced by reeds, sedges and woody hydrophytes. In the deeper headwaters of some of the minor sloughs where

ponds and small lakes occurred, waterlillies and associated water plants were common.

During the last 100 years or so, reclamation activities have removed most of the virgin vegetation. Almost the entire Delta today is utilized for the production of crops. A few scattered areas remain in their virgin condition which support tules and other natural vegetation. The man-made levees began to support vegetation characteristic of the alluvial plains and the banks along the valley streams surrounding the Delta. Similar vegetation is found on natural or "made" land which is higher than the average elevation of Delta lowlands. The type of vegetation depends on whether the soil is organic or mineral in origin and the degree of drainage in specific localities. For example, along the Sacramento River levees where the soil is quite mineral, cottonwoods, willows and water-loving perennials grow near the waterline and oaks, buckeye, blackberry briers and rye grasses grow higher on the levee section and adjacent higher sand, silty and loamy lands. In the central part of the Delta where soils are organic in origin and drainage is very poor, cottonwoods, willows and blackberries are found but the tules are more commonplace.

Through the years many plants have been introduced to the area by domestic and utilitarian landscaping activities around settlements, farmsteads, commercial and recreation

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developments. In some areas, plants have been introduced for the purposes of soil stabilization, wind screens, aesthetics and shade. Occasional escapes of these introduced species can be found intermingled with the native material of the area. The most common exotic trees observed are: Eucalyptus, Poplar, Locust, Accacia, Palms, Monterey Pine, and Arborvitae.

Water Quality

Two major problems relative to water quality face the economic and recreational future of the Delta. One is salinity incursion which results from incoming and ebbing ocean tides through the Delta waterway system. Since 1900, the expanding use of fresh water throughout and upstream of the Delta increased the salinity incursion, particularly during the summer months. With development of the Central Valley project storage in Shasta and Folsom Reservoirs, fresh water releases were available to combat the saline water. While these releases have maintained a reasonable rate of salinity control, they have also encouraged further development which demands more fresh water. Along with municipal, industrial, and agricultural demands, recreational use of the Central Valley Waterways also places demands on the fresh water available.

Fresh water is not necessarily a prerequisite for recreational use of our waterways, since the ocean itself

provides a vast play area for Californians. The important item is water movement or water circulation. Without proper circulation, water becomes stagnant and less desirable for recreational use.

Almost every type of recreation use of waterways requires adjacent land to sustain access and facilities for the welfare and comfort of the recreationists. This is especially true of swimming and boat-oriented picnicking and camping. Ideally, the land should be in keeping with the notion of a natural outdoor experience. In the Delta, many of the opportunities remaining for these pursuits are in and along the fringes or deadend sloughs where the tidal fluctuation and the incoming fresh water flows are insufficient to circulate channel waters. Consequently, these areas tend to become brackish, stagnant and susceptable to pollution.

Water pollution is the Delta's second major water quality problem. Pollution of the Delta waters has been mainly associated with discharges of undisinfected sewage and industrial and agricultural waste effluent which usually reaches a peak in the late summer when recreation use in the Delta is the greatest. Federal, state and local health departments, Water Quality and Water Pollution Boards are working with all concerned to identify and solve waste problems. Indications are that water-body contact recreation activities may have to be curtailed in some areas at times until these problems can be satisfactorily brought under control.

With the exception of the Stockton area, water pollution does not present serious problems to recreation use of surface water in the Delta provided that sufficient treatment and release controls can be maintained and that adequate flows are available to circulate and disperse treated releases.

The contribution to pollution that recreation activities make has not been clearly identified in the past; but it is assumed that while it must be recognized as an increasing amount, it is relatively insignificant when considering the overall problem.

It must be recognized, however, that in areas where high concentrations of water-oriented activities and boat use are proposed measures should be taken to prevent pollution to assure the maintenance of good water quality at all times.

Vehicular Transportation

There are approximately 1,000 miles of paved roads in the Delta and probably again as many miles of dirt roads on the narrow levee crowns intertwined throughout the area. Most of the dirt roads are used purely to provide levee maintenance access or farm machinery and utility access. Many are private roads or special-use roads restricted against public use.

Most of the paved roads are also confined to the crowns of levees around the islands and tracts. Inter-island traffic on secondary roads usually is dependent on ferries across the waterways. The major uses of the secondary road system are local farm-to-market commerce and public access to numerous marinas, boat clubs, hunting and fishing areas and some general sightseeing.

Road construction and maintenance in the Delta is difficult and costly especially in the central part where unstable peat foundations exist. This condition results in periodic reconstruction of levees and roadways to compensate for land subsidence and consolidation. These problems are reflected in the development of the state highway system in the Delta area. With the exception of state sign routes 4 and 12, which cross the Delta in east-west directions, the highways tend to circumvent the major portion of the Delta.

The open space and rural character that the Delta offers in the tremendous urban expansion due to surround it will be of even greater value to the population in the future. While it is evident that some portions of the Delta still remain somewhat remote due to lack of good road access, the rural open space nature of the Delta has been preserved by this happening. For, with good highway access comes greater demand for intensified development.

An improved road system will unquestionably be an economic advantage to the local agricultural industry and an expanded road system would be more attractive to the recreation industry; however, planning of these roads should consider the long-range effect that they will have on the overall character of the Delta. Recreational use of the road system can be expected to increase and will influence to a greater extent the location and design of alignments. There will, however, be areas in the Delta where vehicle access will not be in the best interest of preserving the remoteness nature which still exists.

California's projected freeway and expressway system does not affect the major portion of the Delta, locationwise. It will influence travel times and accessibility to the Delta from urban centers throughout the State. The most significant of the proposed routes, Interstate 5, is now under construction north and south of the Delta region. Construction will soon begin north from Stockton to Sacramento, with completion scheduled early in the 1970's. Interstate 5 traverses the Delta along its east side to provide statewide access directly to this, one of the most significant recreaction resources in California.

Interstate 205 will provide excellent access to the southern Delta area from the San Francisco Bay region. This adopted route will connect the Westside Freeway to the freeway system in the Bay area to complete an interstate freeway network that completely encircles the Delta.

Population

The Sacramento-San Joaquin Delta is located within a region surrounded by a metropolitan complex experiencing the highest rate of population growth in northern California. At present, the Sacramento-Stockton-East Bay Metropolitan Complex contains approximately 20 percent of the state's total population, totaling some 3.7 million people. By 1980-1985, this figure will have increased to between 5.5 and 6 million.

This future population growth will bring development for housing, commerce, industry and transportation which will engulf developable lands all around the Delta. Such urbanization can remove and push back open spaces which provide the environment for outdoor recreation, and habitat for our fish and wildlife. However, with proper planning the Delta can become a vast park centered within what is certain to be a large metropolitan complex.

As the population grows in this region, increased demands will be placed on the Delta's recreation resources and facilities proportionately. Combined with demand pressures generated throughout the state's population, it is predicted that by the year 2020 the fantastic number of 195 million visitor-days will be demanded for recreation activities in the Delta.

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CHAPTER III. DELTA RECREATION - GENERAL CONSIDERATIONS

Since about 1930, when striped bass fishing began to be a popular sport, and even more significantly and rapidly since about 1948, recreational use of the Delta waters has grown in importance and magnitude. Pleasure boating of all kinds - fishing, hunting and sight-seeing - are now providing an important recreational outlet for many Californians and particularly for the growing population of the San Francisco Bay-Stockton-Sacramento metropolitan complex.

This growing demand for recreation resources and facilities has posed problems for officials, proprietors and landowners with interests in the Delta. A maze of water rights, property rights, navigation rights, and squatters' rights has compounded the difficulties. Hordes of people, intent on finding a place to go for fishing, picnicking, swimming, or just "outing", move into the Delta without regard for the presence or absence of public areas and facilities to support their recreational sanitary needs.

Present Recreation Use

The primary measure of recreation use employed in this report is the "visitor day", which is a visit for the purpose of recreation, by one person for a part of a

day. It may be as brief as an hour or it may be as long as 24 hours. Brief views, as from a highway, are not visits in this sense, nor are brief stops at such places as overlooks.

Talking about numbers of visitor-days in the Delta is only vaguely descriptive of the actual pressure of need for places where people can go. In 1963, an estimated 2.4 million visitor-days of recreation use occurred in the Delta. A disproportionately large part of this use appeared in very small and especially sensitive areas in the Delta.

In 1962-63, a survey was conducted of recreation use in the Delta. This survey lasted for 11 months during which samples were taken at 35 locations. All significant outdoor recreation activities were sampled, and the results compiled by electronic data processing. It was found, as expected, that parking facilities and access to the water were the critical needs for land-based recreation, and mooring areas or "places to go" were the major demand of boaters.

On one day during 1963, there were more than 12,000 boats moving in the Delta at one time. While there are over 700 miles of waterways in the Delta, recreation boaters tend to congregate in relatively small parts of the available network.

There are several kinds of boating use, the requirements for which are largely incompatible with each other. For instance, boat fishing is uncomfortable and often unsafe in channels used by cruisers and water skiers. On the other hand, boat fishing interferes with waterskiing which requires

unrestricted use of the water. Sail boating, now enjoyed by an increasing number, exerts conventional and legal rights over other forms of boating and is, to that extent, incompatible.

Conflicts of waterway use can be eased by waterway use zoning. This can be done by either time zoning or area zoning, or a combination of both. Zoning, however, to be effective must be adequately enforced. A plan for waterway use is presented in this chapter.

A large majority of all boating involved at least some fishing as part of the recreation day. This incidental fishing was mainly for warmwater fishes, including crappie, bluegill, catfish and largemouth black bass. The majority of fishing, however, was for striped bass, and most striped bass fishing occurred during the months of September, October, November and December.

As in most other places and forms of outdoor recreation, the major season in the Delta is during the school vacation period extending from about June 1 through Labor Day. During this time, the facilities for public use are overtaxed on all weekend days, and on many week days.

It was found to be impossible to measure the number of people turned away by the operators of recreation facilities in the Delta, or to estimate the number of people who stayed away because of known crowding.

Future Recreation Demand

Estimates of future recreational demand were based on conventional projections of population increase and economic growth. A projection of the Delta recreation demand was made for each decade until the year 2020. Table 1 shows this demand by decades.

TABLE 1

RECREATION DEMAND IN THE DELTA
1960-2020

Year	Recreation Demand (Visitor-days)
1960	2,406,000
1970	5,451,000
1980	12,386,000
1990	27,711,000
2000	54,172,000
2010	104,499,000
2020	195,225,000

It is predicted that sometime around the year 1990, recreation demand will begin to exceed recreation use due to capacity limitations. However, existing land uses could drastically change and more land might become available for outdoor recreation purposes. In addition, should our open spaces decrease, as our population increases, people will undoubtedly become more tolerant to crowding in order to enjoy the out-of-doors.

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Delta Master Recreation Plan Concepts

The purpose of the master plan is to serve as a guide for preserving and developing the Delta's scenic, wildlife and recreational resources. Principles which were followed in developing this plan were based on the following. Future planning should include the same considerations.

1. Existing land use and ownership was given full consideration. No change in land use was recommended except as essential to the plan.
2. The master plan should remain flexible to accommodate changing needs of recreation and other uses.
3. Private and local governmental development and operation of recreational facilities is to be encouraged.
4. Future land and water use and development should reconcile incompatable uses and recreation developments receiving highly intensive use should be clustered.

General Considerations

Present recreational use of the Delta, by any standards, is high. This high use is particularly significant when considering the almost total absence of public facilities. Much of the high use can be attributed to the 700 miles of navigable waterways, all of which are in the public domain.

Free access to these waterways is a wonderful opportunity afforded Californians and, understandably, they are attempting to enjoy this opportunity to its fullest. Statistics show that nearly 100% of the present recreational use is water-oriented.

However, free access to this water wonderland only applies to the waterways. For once the recreationist steps on dry land he is trespassing since a very small portion of the Delta's lands adjacent to the water are publicly owned. The problems this poses to the recreationist who desires to beach his boat for a picnic, or to the bank fisherman wanting to try his luck, are obvious. But, trespassing also poses a problem for the land owners who are confronted with trash and litter, levee damage and the like.

Recreational use of the Delta's waterways is, by and large, unregulated. Conflicting recreational uses can, and do, spoil the recreation experience of many and the threat to public safety and private property is an obvious one. Local law enforcement officials are doing an excellent job in trying to cope with these ever-increasing problems, but the time is fast approaching when more regulatory efforts

must be made. All levels of government can and should assist in solving these regulatory problems.

Future recreational development can not only provide the facilities presently needed, but can also, if properly planned, do much to alleviate increasing problems and preserve and enhance the recreational resource.

Water Use Plan

Nearly all of the Delta's present and potential recreation use is water-related. A master recreation plan for this region would not be complete without a plan for orderly recreational development and use of these waterways.

In order to prepare a water use plan, several considerations were made. First, the present recreational use of Delta channels was determined. Questions such as which channels were now being used for fishing, water skiing, cruising and mooring areas had to be answered. Second, the resource itself was evaluated. Scenic beauty, commercial recreational development, wildlife habitat, water quality, adjacent land use, existing and proposed land uses -- all factors relating to the Delta's resource values were evaluated.

A preliminary plan was prepared and each county affected was asked to comment. The preliminary waterway use plan was reviewed at the local level by both planning and law enforcement staffs. The plan presented in this report reflects their comments.

The water use classifications presented here are based on present and anticipated water and adjacent land use, the related resource values and the requirements for recreation, wildlife and waterway traffic. This plan will serve to optimize use of the available resource, minimize conflicting and incompatible uses and provide the opportunity to regulate and enforce waterway safety.

Such a plan, however, should be broad and flexible in order that future use and development can be adaptable to unforeseen changes and requirements due to future recreational trends and needs.

The plan presented here delineates five broad categories or classifications of waterway use. These are:

1. Unrestricted Use Areas. Channels so designated provide sufficient water surface to allow all types of recreational use or can serve as major navigational arteries for travel throughout the Delta.
2. Restricted Use Areas. Limitations, primarily on speed or boat wakes, should be mandatory on these channels because of water-side developments such as commercial mooring areas, berthing facilities, botels, marinas, beaches and park areas or where boating traffic is congested.

3. Intensive Use Areas. This classification applies to those areas more suitable to active or intense use. Activities in these areas could include water skiing, swimming, boat picnicking or fishing; however, all of these uses might not necessarily be compatable. Future planning would require careful consideration of optimum use based on the available resource at specific locations and would generally dictate separation of incompatable uses. Types of facilities in these Intensive Use Areas should relate to the activities encouraged and access would be primarily by water. Where adequate roads could serve Intensive Use Areas, land access with adequate parking facilities could be provided.

4. Protected Use Areas. Areas within this category exhibit scenic environment capable of providing recreation more related to extended periods of visitor use. Use should, therefore, more directly relate to the environmental characteristics of the area. Uses could include boat camping or mooring, picnicking, quiet boating, swimming, fishing, hiking, sight-seeing, and, in some instances, limited water skiing. However,

incompatable uses would require separation. Access should be provided by water and, in areas readily accessible to public roads, land access and related facilities could also be provided.

5. Natural Use Areas. Areas within this classification exhibit outstanding scenic, aesthetic and wildlife values which should be preserved and protected in order to perpetuate the Delta's wilderness characteristics. These characteristics would provide opportunities for solitude. provide sight-seeing and scientific study and preserve and protect the abundant wildlife. Slow boat cruising and canoeing should be permitted in addition to hiking and fishing. Access should be limited to water access only. Bank fishing could be permitted but land access facilities in the immediate area could prove detrimental. Land access, therefore, would best be limited to trail access.

All general and specific recommendations of this recreation master plan are in accord with the foregoing water use plan. Plate 3 entitled "Waterway Use Plan" delineates each channel with respect to its recommended recreational use.

The broad concepts of water use classifications presented here should be formally recognized and adopted by the State of California, the Federal Government and the Delta

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area counties. Several methods of implementation are readily available through exercise of present authorities at all levels of government. Future action programs by governmental organizations can offer major impetus to a waterway use plan by simply following it.

Local government can assist by adopting compatable zoning ordinances on lands adjacent to the waterways.

The State Reclamation Board and the U.S. Army Corps of Engineers should be enabled to exercise more discretion in granting levee and navigational encroachment permits as appropriate to their respective regulatory powers.

The State Department of Parks and Recreation should designate the use of the Delta's waterways in accordance with the broad classifications recommended here by providing adequate channel markings. This can best be carried out through the Division of Small Craft Harbors in collaboration with other affected State and federal agencies and with local planning and law enforcement officials.

Debris and Snag Removal

A common and increasing complaint throughout the Delta concerns those problems associated with trash along the levees, floating debris and submerged snags. As recreational use of the Delta's waterways continues to increase, these problems are certain to increase

correspondingly. Steps must be taken now to insure public health and safety and to eliminate these hazards to property and life. The elimination of these nuisances is a public responsibility and the problems can be solved by more diligent attention to administrative responsibilities now existing and by new legislation where present authorities are inadequate.

Much broader interpretation can and should be given to existing federal authority for the removal of submerged snags and floating debris. Broader interpretation should include the recognition of hazards to recreational navigation as opposed to just commercial navigation. In addition, this policy should be applied to all open channels and sloughs of the Delta since they are all, in fact, navigable. The U.S. Army Corps of Engineers should augment their present channel clearing program in the Delta as necessary. It is recommended that the Corps, in collaboration with the Division of Small Craft Harbors, undertake an immediate investigation to determine the necessary magnitude and requirements of an augmented program and to establish priorities of work based on navigational requirements. Most importantly, it is recommended that such a study be done in cooperation and consultation with all the affected Delta county governments.

State and local governmental officials should actively support the Corps of Engineers and assist them in obtaining congressional approval for an expanded operational

program.

The State Reclamation Board, under existing police powers established by the State Water Code, can alleviate much of the floating debris problem by more rigid control of unlawful levee encroachments. Much of the floating debris appearing in the Delta, particularly during periods of higher flows, originates from trees and brush cleared from the levees in the summer months and unlawfully left on the levees. The Board should be given more support to exercise its authority through more adequate staffing for inspection and law enforcement purposes.

Trash left by recreationists along the levees is becoming an increasing problem and is unsightly and a threat to public health and safety and, in many instances, is causing an undue hardship to private landowners. The responsibility rests with the users of the public waterways and it is only equitable that the responsibility for alleviating this nuisance belongs to the public at large.

California's anglers are now financing a stream-side anti-litter campaign pursuant to Section 5652 of the State Fish and Game Code. This program supported by the Department of Fish and Game's license proceeds is leveled at all water area users and not solely anglers.

However, the problem persists, additional remedies are needed and the boating public at large, in addition to anglers, should share in this responsibility.

A logical solution would be a program for local litter collection and removal financed at least in part from State funds. The State agency with which this responsibility should be fixed is most logically the Division of Small Craft Harbors.

The Division of Small Craft Harbors, in consultation with local officials, should immediately investigate the operational and fiscal requirements of such a program and take steps to implement a cooperative program with local governments.

Lands administered or maintained by other public agencies upon which no sanitary or trash collection facilities are provided should also be maintained by cooperative agreements with local governments and financed by the public agency administering the lands involved.

Greater emphasis should be placed on educating the water recreating public concerning their responsibilities and particularly the compounding of costly governmental programs as a result of their negligence. Finally, all law enforcement agencies of the State, and particularly those of local government, should re-assess their law enforcement activities as authorized by Section 5652 of the State Fish and Game Code and make certain they are doing all that is possible.

The Role of the Private Sector

There are 151 boat marinas or installations within the area of investigation. Located at these installations are approximately 3931 covered boat slips, 3723 open slips or dock spaces, 469 covered dry boat storage spaces, 720 open dry boat storage spaces and 83 lanes of launching ramps. The present total capital investment of Delta boating facilities is estimated to be $10.6 million. Approximately $9.9 million, or 93.5 percent of this total is in the realm of the private sector.

It is concluded that the State should not finance small craft harbors or other types of revenue-producing facilities in the Delta as long as private investment continues to meet the demand.

It is impossible to say which sites in the Delta would be most profitable for private investment. It appears likely, however, that sites with the most favorable access to and from both land and water or lying closest to areas of existing urbanization will have the highest potential for private development.

All of the area designations shown on Plate 3, excepting the "Natural Use Areas" could be considered suitable for certain types of commercial development providing such development was compatable with the uses outlined.

It is strongly recommended that all harbor facilities to be built in the future be constructed behind protective berms or in dredged areas behind the levees. Too many of the Delta waterways are being encroached upon by water-side developments with the resultant necessity for reduced speed zones and other restrictions.

The Division of Small Craft Harbors, in collaboration with the Wildlife Conservation Board, should continually re-examine Delta boating needs and if private or local development begins to fall short of supplying the demand, the State should begin an action program offering State assistance. The Division should remain ready now, however, to offer whatever assistance might be required. Local governmental agencies should assist the orderly development of harbor facilities by enacting appropriate zoning laws.

The Role of the Public Sector

The critical needs of the Delta recreationist, such as public access, camping and picnicking facilities, parking facilities, mooring areas and a general need to preserve a dwindling resource of scenic beauty, wildlife habitat and open spaces, indicate that the major role of recreation development lies in the public sector.

The following chapters of this report detail the major elements of this master plan and delineate the role, primarily, of the State and federal governments. Major emphasis,

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however, is placed on the recommended role of the State of California.

Though the Delta is of State and even national significance, the recreational development of such a vast resource is beyond the capability of the State or Federal Governments alone. County and local governments should be encouraged to develop these resources wherever possible. The following areas exhibit major recreational, wildlife and scenic values which would specifically lend themselves to county or local development and operation.

1. Beach-Stone Lake Area
2. Dry Creek-Mokelumne River Area
3. Elk, Sutter and Steamboat Sloughs
4. Southwestern tip of Grand Island
5. Disappointment Slough
6. Fourteen Mile Slough

CHAPTER IV. LEVEE CONSTRUCTION AND MAINTENANCE

Levee Construction

The Delta area is the focal point for the discharge of drainage and flood waters for both the Sacramento and San Joaquin Valleys. Soil deposits from the river systems and the growth and decay of plants in the marshy areas have developed a very rich soil, so that reclamation of these lands for agricultural purposes was begun early in the history of California agriculture. Because of the unique geographical location, there is a wide range of hydraulic conditions in the waterways including high water and rapid currents in the floodways which sometimes endure for long periods. High tides and wind-induced waves may also add to the problem of protecting the Delta lands, and the condition becomes particularly critical when all three of these factors coincide.

Historically, the Delta area was reclaimed by local landowners, either individually or through organized districts, who progressively raised dikes and levees, first by hand and later by machinery. Most of the existing levees in the Delta were constructed by clamshell dredges, dredging saturated sand and peat from the channels in front of the levees. This method did not result in uniform sections and, due to the limited reach of the booms on the dredges, the

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levees were often located adjacent to the channel with little or no berm. These early levees were not designed or constructed to currently-accepted engineering standards.

Dredging of material from in front of the levees often left narrow low-lying islands beyond the borrow pits. These islands typically were covered with tule growth and provided wind and wave protection to the levee slopes. However, many have since eroded and the growth has disappeared, leaving the levees unprotected against attack from flood currents and from waves caused by winds and boat wakes.

The levees of the central Delta are founded on and constructed of local peat material. The peat has low density, low sheer strength, and high moisture content which is largely retained even after consolidation over a period of years. This organic material does not consolidate readily and, as more material is placed on the levees to raise the height, the lack of firm foundations may allow subsidence. Foundation failures and subsidence are common in the central Delta, due to these low-strength materials and aggravation by seepage and the development of gases in the underlying peat. Levees around the periphery of the Delta and along the main channels of the San Joaquin and Sacramento Rivers are generally constructed of better material and based on better foundations; but the materials used are still those found at the sites and are often far from ideal. Excessively sandy material is fairly common, but the subsidence problem is not so prevalent in these areas.

Approximately 55 percent of the reclaimed islands in the Delta are from 5 to 20 feet below sea level, resulting in a constant water pressure and seepage through and under the levees. Lands in the periphery of the Delta are not so low lying, but there, winter flood flows may raise the water level in the channels to well above sea level for several weeks at a time. This results in high-seepage pressures with the additional problem of relatively high-water velocities and the consequent erosion potential.

The present methods for construction of levees utilize, where possible, large earthmoving machines and equipment, including dredges, carryalls, bulldozers, rollers, and dump trucks. The larger equipment, however, cannot be operated on the levees in some sections of the central Delta due to the presence of organic peat materials and the possibility of subsidence, seepage, and other factors. In such cases the work is usually done by floating dredges. If other equipment is used, the size and speeds must be carefully limited.

Since the advent of the Sacramento River Flood Control Project, the Lower San Joaquin River Flood Control Project, the Stockton Deep Water Channel, and the availability of public funds for other major repairs and rehabilitation of levees, a significant proportion of the levees in the Delta has been designed and constructed by the U.S. Army

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Corps of Engineers. At present, there is no program for participation in levee design or construction by organizations or agencies charged with responsibilities other than flood control. Although the flood control interests now recognize the value of recreation, scenic beauty, and wildlife preservation, a specific program for meeting these requirements without jeopardizing flood control has yet to be worked out. In addition, funds must be made available in order to implement such a program. The existing levees fall into three categories:

Project Levees - Those constructed or rebuilt by the U.S. Army Corps of Engineers and maintained to federal standards by or under the supervision of the State of California. These include statutory levees, state maintenance area levees, and those maintained by local districts.

Direct Agreement Levees - Those levees repaired by the U.S. Army Corps of Engineers following major breaks or failures and maintained to federal standards under the supervision of the Corps.

Non-Project Levees - Those levees constructed and maintained by the private landowner and not required to conform to any standards of maintenance. These levees comprise over one-half of the levees in the Delta.

The distribution of the various categories of levees within the study area is shown on Plate 4, "Categories of Existing Delta Levees".

The U. S. Army Corps of Engineers has established standards for construction of Project Levees. The majority of the Delta levees do not meet these standards, and it would be impossible in some cases to do so because of limited materials and foundations.

Levee Maintenance

Levee maintenance in the Delta has been in the past, and is today, performed solely for the purposes of flood control and is financed primarily by the property owners protected. No responsibility has been assumed nor have any funds been contributed by interests or agencies representing any purpose but flood control.

In some instances, the methods used are the result of legal commitments. More generally, these methods are the result of physical limitations and economics. Physical conditions vary widely and the economic factors may include not only the cost versus benefit aspects of the maintenance work itself, but also the financial condition of the individuals or district performing the work. The result is extreme variation in methods of maintenance, costs incurred, and degrees of performance.

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Responsibilities

The responsibility for levee maintenance rests primarily with the property owner in the area protected. In most cases, this responsibility is discharged by a reclamation or a levee district rather than the individual owners. In the case of most Flood Control Project Levees and so-called Direct Agreement Levees, legal commitments requiring the maintenance of the levees to definite standards have been made. The actual maintenance work on some Project Levees is performed by the California Department of Water Resources. This work includes statutory levees which are maintained at state expense because benefits accrue to large areas and the costs cannot be allocated, and also levees in state maintenance areas formed by the Reclamation Board at the request of local districts or because of deficient maintenance by the districts. The costs for the latter category are reimbursed to the State through local taxes.

Non-Project Levees

Non-Project Levees, defined as those levees which have been constructed by private interests with no contributions of public funds, are maintained by the owners, or by the districts representing these owners, using the methods and meeting the standards which they deem satisfactory. By law, the State Reclamation Board has the responsibility to review and approve plans for work on levees which, although privately owned and maintained, may affect the flood control project.

Flood Control Project Levees

The responsibility for maintenance of Flood Control Project Levees rests primarily with a local interest or property owners. Again, this responsibility is generally discharged by a district rather than individual owners and, in this case, the districts generally have signed agreements to maintain these levees to standards prescribed by the Federal Government. Exceptions to this are certain levees involved as part of the old Sacramento River Project and which, by law, are maintained at state expense.

Assurances for maintenance of Flood Control Project Levees were made to the Corps of Engineers by the State Reclamation Board which, in turn, required the assurances from the districts or landowners involved. In some cases where this maintenance work has not been performed properly or the district has requested state assistance, maintenance areas, in which the Department of Water Resources does the actual maintenance work and is reimbursed through local tax agencies, have been formed.

Direct Agreement Levees

Direct Agreement Levees are levees not included in the Flood Control Projects but on which the U. S. Army Corps of Engineers has done major construction or rehabilitation work. This classification includes some levees involved with the Stockton Deep Water Channel and some levees upon which major work has been done after flood damage. In

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most instances, an agreement has been made between the local landowners or district and the Corps of Engineers to maintain the levees in accordance with federal regulations. In the case of the levees along the Stockton Deep Water Channel, this assurance was provided by the Port of Stockton, but actual responsibility for the maintenance work has not been accurately defined as yet.

Objectives of Maintenance Work

The purpose of maintenance work is to ensure a sound levee structure which will adequately protect against floods. To serve this purpose, the condition of the levee must be such that adequate inspection can be carried out and the necessary work on the levee can be done. This work includes elimination of rodents and repair of burrows, repair of erosion damage, repair of damage by toppling trees, removal of dangerous trees, and the placement of slope or toe protection where necessary. Another purpose of levee maintenance is to retain the levee in such condition that emergency patrolling and flood-fighting activities can be carried on if necessary.

Levee Maintenance Regulations

Only about 46 percent of the Delta levees are subject to federal maintenance regulations; 8 percent are Direct Agreement Levees and 38 percent are Flood Control

Project Levees. These are all levees on which federal funds have been expended and, in authorizing the participation, the Congress of the United States required assurances that the levees would be maintained in accordance with regulations prescribed by the Secretary of the Army after the authorized construction work was completed.

In the case of Flood Control Project Levees, the State Reclamation Board has provided assurances to the Corps of Engineers that maintenance will be performed according to regulations and, in turn, has required similar assurances from the landowners or districts. The actual work of maintenance is normally done by local districts or landowners, but the Reclamation Board is given the authority to have the California Department of Water Resources take over maintenance if local agencies fail to conform to the regulations. The local districts may also request that maintenance be taken over by the State.

The Department of Water Resources, if so directed by the State Reclamation Board, will take over actual maintenance in areas of deficiency.

U. S. Army Corps of Engineers

The regulations for maintenance of Direct Agreement and Flood Control Project Levees form Part 208, Chapter II, Title 33 of the Code of Federal Regulations, and have the

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effect of law. These regulations form a nation-wide standard against which to judge the maintenance of Corps of Engineers levees and are supplemented on individual projects by operation and maintenance manuals which cover special requirements of the particular projects. Copies of the operation and maintenance manuals are furnished to the Reclamation Board and to the maintaining agencies upon completion of each unit of a project.

The federal regulations for levee maintenance prohibit brush, trees, and wild growth other than sod on the levee crown and slope. However, the Corps of Engineers "Maintenance Manual for the Sacramento River Flood Control Project" makes the exception that brush and small trees may be retained on the waterward slope where desirable for the prevention of erosion and wave wash. This exception does not define what constitutes small trees and brush nor does it define when they may be desirable, but it does definitely show that modifications of the basic maintenance standards are possible if the modifications can be proven to be desirable.

State Reclamation Board

The State Reclamation Board furnishes the written maintenance assurances called for by the United States Congress when authorizing flood control projects within the Sacramento and San Joaquin Valleys. The Board, in turn,

obtains written assurances from the landowners or districts and is responsible for enforcing the regulations. This Board also has the responsibility for reviewing applications for encroachments on the levees and setting standards for construction of authorized encroachments.

Department of Water Resources

The Department of Water Resources has supervisory power over the maintenance and operation of flood control works of the Sacramento River and San Joaquin River. These supervisory powers and duties of the Department include the works maintained and operated by local agencies without regard to the construction, status of completion, or expenditure of federal funds on such work. Within these projects, certain of the levees are maintained at state expense while others have been turned over to the Department as maintenance areas at the direction of the Reclamation Board. The costs for these latter are apportioned upon the property benefited within the maintenance area on an ad valorem basis.

The Department reviews plans of construction and improvements or other work affecting the Sacramento and San Joaquin Flood Control Projects for the State Reclamation Board. If the proposed work is approved by the Board, the work is done under the direction and supervision of the Department of Water Resources.

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Variations in Performance of Maintenance

The variations in performance of maintenance occurs not only between the various categories of levees found in the Delta, but within each category. These variations result not only from the attitude and economic capabilities of the maintaining agencies but also from such factors as levee design, levee and foundation materials, and hydraulic conditions.

Levees on organic, or peat soil present unique maintenance problems because of land subsidence and frequent slippages on the levee slopes, particularly the landward slopes. Adding material to increase freeboard, or placing rocks for revetment must be done very cautiously because the extra weight may cause a foundation failure and subsidence of the levee. The Department of Water Resources, in their levee test program[1], found that levees on organic soil, if constructed with a land-side berm, provided a better structure than the standard design. If this design could be utilized, present maintenance problems on these levees could change; but at present none of the levees in the central Delta are constructed to this design.

[1] Delta Test Levees Investigation, California Department of Water Resources, November 1963.

The attitude of the maintaining agencies plays an important part as to the consistency or regularity of the maintenance performed. State-maintained areas receive annual maintenance whereas many levees, both Project and Non-Project, maintained by local agencies receive attention only when the integrity of the levee is obviously in question. This neglect may be due to indifference or to the financial condition of the maintaining agency at the time.

Historical Costs For Levee Maintenance

Little data is available on historical costs of levee maintenance. The cost records on private maintenance programs are typically kept only as a part of a larger operation; where records are available, it is difficult to determine whether the costs represent a real average annual cost or if deferred maintenance is a factor. The true costs for maintenance undoubtedly vary, depending on the material and section of the levee, the exposure to flood flows and wind waves, and the incidence of boat and ship traffic.

Reported costs of six districts, ranging from New Hope to Empire Tract and Sherman Island vary from under $200 to $1,100 per mile per year. These records cover periods of 6 to 11 years between 1951 and 1964. Costs for five State Maintenance Areas on the Sacramento and American Rivers during the fiscal years 1962 and 1963 varied from $450 to $850 per mile per year, excluding maintenance yard support and general supervision.

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These data on historical maintenance costs have not been adjusted for inflation during the periods of record; and it is not possible to ascertain whether they represent true average annual costs. In some cases, work may have been deferred and the reported costs may be too low; in other cases, the opposite may be true. However, it can be safely concluded that the true cost of maintenance may vary by at least a factor of six, depending on the location, exposure, and material of the levees.

Benefits of Vegetation on Levees to Flood Control

Federal regulations recognize the advantage of vegetation on levee slopes. The "Maintenance Manual for the Sacramento River Flood Control Project" makes the stipulation that "brush and small trees may be retained on the waterward slope where desirable for the prevention of erosion and wave wash". This concept has generally been incompatible with the present economic and practicable methods of levee maintenance solely for flood control purposes. However, it can be assumed that alternative methods to provide scenic beauty, wildlife habitat, and recreational benefits on levees can also yield benefits for the flood control purposes of the structures.

Any program to provide for controlled vegetation on levees must entail a comprehensive and continuous maintenance program as well. Such a program will automatically lead

to a better average level of performance in maintenance operation and will provide some additional margin of safety for flood control purposes.

Scenic Beauty on Levees

Scenic beauty, although an intangible value, is becoming more and more recognized as a worthwhile objective. President Johnson's message to the 89th Congress on the natural beauty of our country stressed the importance and need for scenic beauty and asked for the establishment of a National Wild River System.

The scenic beauty of levee vegetation lies not in any particular kind of tree, shrub, or grass but in the effect of a combination of these plants on the overall beauty of the waterways or highways.

In the past, beauty in the Delta has been exemplified by thick underbrush and trees overhanging the waterways, and this type of vegetation is what the majority of waterway and highway users now consider ideal. However, if adequate maintenance is to be performed, it will be impossible to retain such pristine conditions on the levee slopes and a compromise must be achieved. This compromise must assure the safe condition of the levees, allow for flood fighting, and, as nearly as possible, meet the requirements for scenic beauty, wildlife habitat and recreational uses.

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The problems of retaining vegetation on berms and most channel islands are simpler than on levee slopes and the necessary control is much less rigid and all possible advantage should be taken of these features. The scenic beauty of many waterways can be greatly enhanced by improvement of waste islands in the channels, particularly where flow capacity is not critical. The level of small areas on these non-leveed islands could be raised high enough by dredging to support tree growth. Selected trees with wildlife and scenic beauty values could then be planted, or native species such as willows, alders, and poplars could be allowed to grow undisturbed. These improvements would add much to the desired effect and would be completely compatible with levee maintenance.

Wildlife on Levees

Wildlife species require food, water and cover for survival. Food and water conditions are satisfactory in the Delta but levee vegetation, and trees in particular, comprise the last remaining habitat available to provide cover requirements for over 100 wildlife species. The destruction of levee vegetation will mean the eventual elimination of these species from the Delta. Thus, the protection of the Delta's wildlife resource from extinction is one primary value of levee vegetation. This value will be increasingly important to all recreationists when the scarcity of wildlife elsewhere in the State becomes apparent.

Wildlife preservation could be accomplished by retaining vegetation on the land-side, but there are several disadvantages to this concept. In the first place, vegetation on the land-side slope of the levees is much less compatible with inspection and flood-fighting requirements. Furthermore, this would retain most of the wildlife on the side away from the area where it could be enjoyed most by recreationists. Finally, land-side vegetation, while it improves the beauty from levee roads, will do little to enhance the beauty of the waterways which are viewed from both the levee and the water.

The values associated with the preservation of wildlife in the Delta area include the recreation dependent upon the production of harvestable wildlife species, the fur taken from animals dependent upon vegetation for survival, and recreation by persons traveling Delta waterways or highways for the purpose of observing wildlife.

Approximately 48,000 visitor-days per year are spent on pheasant, quail, and dove hunting in the Delta area.[2] Pheasant hunting is the most popular and furnishes about 30,000 visitor-days. An average 3.8 million visitor-days each year are spent in the field by pheasant hunters in northern California,[3] indicating that almost 8,000 hunters

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[2] Recreation Appendix, Bulletin No. 76, California Department of Water Resources

[3] Game Management Handbook, Department of Fish and Game

utilize the Delta pheasant resource each year. Quail and dove hunting involves about 6,000 hunters each year who spend about 18,000 visitor-days.

According to the Game Management Handbook, about $30,000 worth of pelts from fur-bearing animals are taken along the Delta waterways by trappers each year. The necessary food and cover for these animals is provided by levee vegetation and waste islands. The three species most important to trappers are muskrats, mink and beaver, which use levee vegetation and waste islands about equally. Other species such as fox, racoon and skunk depend on the landside vegetation, but they are of lesser importance.

Many individuals and groups travel to the Delta to observe the wildlife associated with this particular environment. Naturalists from all over the world and Audubon groups from throughout the United States who come to the Delta hope to see such birds as the White-tailed Kite. Two factors must be considered in determining the importance of this use and its relation to levee vegetation. First, not all wildlife species depend upon levee vegetation for survival and, second, if boats are used, such observations are also tied closely to overall cruising enjoyment.

It should be emphasized that levee vegetation is most important to non-game wildlife, and this is its primary value. Thousands of birds, both resident and migratory,

depend upon this vegetation for shelter each year. Where suitable levee vegetation exists, wildlife numbers will be maintained; otherwise, the species will eventually be lost to the Delta. It is in the overall picture of wildlife conservation and not merely in the production of harvestable game species that levee vegetation is most valuable.

Recreational Value of Levees

The Delta area, with over 700 miles of channels, provides tremendous expanses of water for boat fishing, cruising, water skiing and other water sports; however, the attractiveness of the waterways to recreationists depends to a large extent on the scenic beauty and shade along the levees. Boaters require attractive cruising reaches and mooring areas as well as beaches, picnic grounds, and camping areas accessible from the water. The Delta area also has a tremendous potential for land-based recreation including bank fishing, hunting, and touring in addition to picnicking and camping. These activities pose an additional requirement for automobile access and parking space. Both land-based and water-based recreation are made more attractive if the area supports varied and plentiful wildlife populations.

Conflicts Due to Multiple Use of Levees

The conflicts that must be resolved to provide for multi-purpose use of the levee systems include special

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problems in levee maintenance and flood fighting that must be solved, erosional damage due to public use of the waterways and levees that must be controlled, and the matter of public access and property rights. This latter item includes the question of public entry into what are now essentially all private lands as well as the need for adequate policing to prevent vandalism, littering, and lack of sanitation control.

Some areas of the Delta are physically unsuitable for certain types of recreation and some of the various recreational activities are incompatible with each other. The need for formulation and administration of water and bank-use zoning laws is growing more urgent each year.

Levee Maintenance and Flood Fighting

If trees and shrubs are to be retained on levees, alternative methods for inspection and other maintenance operations must be developed. The characteristics of the plants must be such that the advantages to soil stabilization, wildlife and aesthetics would outweigh any disadvantages to levee maintenance and flood fighting.

Any additional costs for levee construction, maintenance, or flood fighting due to retention of vegetation or multi-purpose use cannot, in fairness, be charged to flood control; therefore, a cost-sharing formula must be developed.

Acceleration of Erosion

Recreational use has tended to increase erosion in the past due to boat wakes at the normal water line and fisherman trails on the levee slopes. This tendency will undoubtedly increase in the future and must be recognized as one of the conflicts between flood control functions and recreational use of the levees. The costs for minimization and repair of this damage cannot, in fairness, be assessed to the flood control function of the levee or to the landowners now paying the costs of maintenance. Public responsibility must be acknowledged and this factor must be considered in the cost-sharing formulas for alternative construction and maintenance methods.

Public Access

Development of general recreational use of the levee system will require that additional access rights be acquired from the landowner and that some agency be charged with responsibility for surveillance and the necessary policing of the area.

Land Rights

There is no legal basis at present for public recreational use of the levee system. Any program to develop the aesthetic, wildlife and recreational potential of

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the Delta levee system must recognize the present private ownership of these lands and must take the proper steps to provide for public access rights.

Proposed Alternative Construction Practices

Funds for the construction of the levees existing today were allocated for the purpose of flood control only and no consideration of other values was involved. The designs have varied somewhat, depending on the agency responsible, the materials available, and the expected hydraulic conditions, but in each case the intent has been to obtain an adequate structure for flood control purposes with the longest useful life possible without excessive costs. Experience has shown that some practices, while they minimize the first costs on a project, necessitate expenditures for major additional work later to preserve the levee. However, if the expenditure is delayed for a long enough period, this still may represent a saving during the overall life of the project unless some additional benefits can be considered.

There are modifications of levee construction practices that will enhance aesthetics, wildlife, and recreation without jeopardizing flood control, but they require legislative recognition of the importance of these values, authorization to the agencies responsible for design and construction to consider these values, and the availability of additional funding.

Berms

A berm on the water-side of a levee does much to absorb the energy of wind waves and boat wakes and protect the toe of the levee from erosion. Many levees have been constructed to provide a berm and others have been reconstructed with a setback for this purpose. In many cases, however, the exposed sides of these berms have not been adequately protected, and they are either gone or fast disappearing due to erosion.

The protection necessary to perpetuate these berms, if provided at the time of construction, will reduce the future expenditures necessary for flood control. If the values of aesthetics, wildlife preservation, and recreational potential are considered, the balance is overwhelmingly in favor of revetment on the water-side of berms at the time of construction.

It is proposed that all future construction or reconstruction of levees, where public funds are involved, include the protection necessary to assure the permanence of any berms on the water-side.

It is also proposed that the repair and revetment of existing berms, under the current Sacramento River Bank Protection Project, be accelerated to reduce the eventual cost of the work, to prevent the serious deterioration of the levees they protect, and, at the same time, provide substantial benefits for aesthetics, wildlife and recreation.

An experimental project to construct a berm in front of an existing levee on Steamboat Slough, without a setback, was recently completed. This type of treatment may be justified on other levees in the future, rather than allowing the levees to deteriorate to the point where major reconstruction is necessary.

Levee Toes Without Berms

Vegetation on many slopes has successfully resisted erosion for long periods, but the continual wave action at normal water levels eventually undercuts the toes and progressive caving begins eating into the levee. Where trees on levee slopes are undercut in this manner, they eventually fall into the river and the root systems often tear a serious hole in the levee slope above.

It is proposed that all future public construction or reconstruction of levees without berms include revetment at the toes to prevent undercutting. Where existing Project Levees have vegetation and the undercutting has not yet become serious, the revetment at the toes should be given priority so that clearing and re-sloping will not become necessary.

Vegetation on New Levees

Unless rock revetment is provided, newly-constructed levee slopes are sometimes damaged due to erosion by waves,

flood flows or rain. Vegetation could help to control this damage and could reduce the need for other slope protection measures; the ideal time to introduce desirable species is when the slopes are clean.

It is proposed that planting of desirable plant species be included as a part of any new construction or reconstruction of levees by public agencies. It is further proposed that these levees then be included in a Uniform Maintenance Program to assure the necessary care during the early stages of growth and provide adequate inspection and control on a continuing basis.

The planting and propagation of new vegetation on newly-reconstructed levees will require extreme care and involve a considerable amount of hand work. It is recommended that personnel from the Youth Authority Training Center, soon to be established near Stockton, be utilized for this purpose. Past experience at the state's Pilot Levee Maintenance Sites has shown that this type of personnel has the necessary experience for establishing and caring for plant materials. In addition, such a program would be beneficial to the Youth Authority Program.

Special Problems in Peat

Levees in the peat land area of the central Delta present special problems. The sections cannot be increased or changed substantially because increased loading or

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excessive vibration may cause movement in the foundations. Re-sloping on the water-side is difficult, or impossible, because the channel is too close to the toe and the levees cannot be set back because the unconsolidated foundation material at a new alignment would take many years to stabilize. Rock revetment does not remain in place properly on the over-steep slopes, and sometimes the added weight causes subsidence.

A recently-developed technique in slope protection involves the use of concrete "waffle blocks", with holes formed vertically through the blocks. This type of protection involves much less weight per unit of area, and the holes will allow regrowth of vegetation after the blocks have been placed.

There has not been enough experimentation, as yet, to completely determine the feasibility of this method for treating the various problems, but it seems to have possibilities for many special situations and could be an answer to some of the problems on peat levees.

It is recommended that studies be conducted to refine the design of the blocks to provide maximum strength, develop means for articulation of the blocks, improve the manufacturing methods and to develop techniques for economical placement of the blocks. If properly developed, this type of slope or toe protection may be more suitable for steeper slopes than rock revetment and, if properly produced and handled, may be competitive in cost.

Purchase of Levees

The required rights-of-way for levee construction and inspection in connection with Project Levees in the past have been obtained mostly in the form of easements. The cost for these easements have often been assessed as the fair market value of the land so that little or no saving has been realized over the cost of buying the land in fee.

The terms of past easements, in some cases, have subsequently proved inadequate to provide the rights necessary for proper fulfillment of the commitments by the State Reclamation Board. There is no assurance that the terms of easements written today will be entirely adequate for the future as urbanization and the pressures for encroachment increase.

It is in the state and national interest for a responsible public agency to have firm control of levee maintenance and encroachments in order to protect the tremendous federal and state investments. The only sure method by which the State of California can guarantee the proper controls is to acquire the levees in fee.

The levee acquisitions should no longer be made on a piecemeal basis. Long-range planning for rights-of-way should be initiated as soon as possible, and all of the levees that are now, or eventually will be, included in

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flood control or rehabilitation projects should be acquired in an orderly manner.

It is recommended that all levees, where public funds have been or will be expended, be acquired in fee.

Present Project and Direct Agreement Levees

Any of the present Project Levees or Direct Agreement Levees on which additional work is to be done and where additional rights-of-way will be required should be acquired in fee with the costs included as part of the project costs. Where no future project work is planned, the levees should also be acquired in fee to assure proper control of maintenance and encroachments as well as provide benefits to wildlife and recreation; but these costs would involve land purchases only and cannot be included in any flood control project funding.

Acquisition in fee of Flood Control Project Levees, where easements have been obtained previously would only involve purchase of the underlying fee value, but the purchase of most Direct Agreement Levees would involve the full value of the land.

Non-Project Levees

The major portion of the Delta levees are not part of any present public project. Any construction or reconstruction undertaken on these levees now is financed privately, and the methods used are those considered satisfactory by the district or individual responsible.

However, the proposed Sacramento-San Joaquin Delta Flood Control Project, now under study by the U. S. Army Corps of Engineers, should be broadened to include benefits for wildlife and recreation, and the California Legislature should be prepared to authorize participation by the State if the findings of the study demonstrate feasibility.

The recommended modifications in construction practices should be thoroughly investigated in the project planning stages as well as the possibility of acquiring the project levees in fee. The engineering and economic feasibility determinations undertaken in the Corps of Engineers' study could be the basis for elimination of those islands which land subsidence and poor foundation conditions make impractical to include in either the Flood Control Project or the Uniform Maintenance Program.

Proposed Alternative Maintenance Method

The objective of the proposed alternative method for maintenance of levees in the Delta is to preserve and enhance the scenic aspects, wildlife habitat and recreational opportunities without jeopardizing the flood protection provided by these structures. It is recognized that any program departing from presently-recommended practices must provide a uniformly high level of performance, even though present methods and practices do not achieve this goal in many cases.

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Although other aspects are involved to a lesser extent, the principal objective of the program would be to preserve vegetation on the levees. To allow this preservation without jeopardizing flood protection, a method for managing the vegetation to eliminate objectionable species and limit uncontrolled growth, and to perform the necessary inspection, repairs and flood fighting is suggested.

It is recognized that preservation of vegetation on levees would increase the difficulty of adequate inspection and limit the economical use of conventional spraying and earthwork equipment. This vegetation would also necessitate special provision for emergency work during a flood fight.

It is concluded that certain types of vegetation would assist in erosion control and therefore can be advantageous, provided the obvious maintenance problems are overcome. It is also recognized that in actual practice vegetation is now allowed to remain on some levees for long periods, and that a comprehensive, uniform program of plant management, inspection and prompt repair work would result in a higher degree of flood protection in many cases.

Concept

The proposed alternative method for levee maintenance would involve the use of highly-versatile, waterborne

equipment and specially-trained crews employed on a continuous basis. The crews and equipment would be assigned solely to levee work, and they would be available for emergency work during floods as well as for routine maintenance. Although basically a water-based operation, some components of the mobile equipment would be designed to land and work from the shore when required.

The program is planned in particular to modify the maintenance methods for the water-side of the levees. Work on the land-side of the levees, and on the water-side of levees behind berms and beyond reach of the waterborne equipment, would be done by land-operated equipment. However, this land-operated equipment would be transported to the site by water in some instances.

The use of Youth Authority wards to assist the levee maintenance crews would be highly desirable, particularly where extensive hand work in the thinning, cleanup and care of vegetation is required. In addition, personnel with this background would be most beneficial in times of flood danger. During the floods of December 1964, the competency of this type of personnel under skilled leadership was ably demonstrated when they were used along the Sacramento River and in the Delta for flood-fighting and patrolling. A Youth Authority Training Center is soon to be established near Stockton.

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Equipment

The basic unit of equipment for the proposed method would be a large, 110-foot by 32-foot, self-propelled barge upon which would be mounted versatile power implements for work over and on the levee slopes and berms. The barge would be powered by a diesel generating system which would provide power to operate the implements and propel the unit. Crew's quarters would be provided.

Other floating equipment would include landing craft (LCM's) which would carry certain pieces of truck-mounted equipment and a small, 25-foot by 50-foot, barge for transporting material, to be towed by an LCM or the large barge.

The purpose of the LCM units, in addition to towing the smaller barge, would be to carry trucks having fittings identical to those on the barge deck, so that either aerial platforms or telescoping cranes could be mounted on them.

At times, one or more of the LCM's could work in conjunction with the large barge, either performing parts of the maintenance work or transporting supplies and equipment. However, the mobility of the LCM's would make them ideal for small isolated problems, so that a significant part of their time would be spent on small jobs remote from the main barge.

Costs and Capabilities on Larger Levees

A detailed estimate of time and costs for the specialized maintenance operations on a large levee was made to predict what the maximum costs for the proposed Uniform Maintenance Program might be. The levee was assumed to have revetment to the level affected by wave wash at normal water stages and grasses above this zone. The scenic beauty and recreational value of the reach was assumed to be enhanced by the retention or planting of trees and shrubs on the levee slope. The location of the trees was assumed to vary from the zone of revetment to just below the levee crown, with the spacing variable, and with an average of about one hundred trees per mile. Shrubs were assumed to occur in small clumps on the average of at least four clumps per mile.

This example would pertain to major levees along the Flood Control Project, where the material is predominantly inorganic, and the freeboard required for flood flows results in a large area of levee slope being exposed during normal water levels. Costs for maintenance of this type of levee would represent the maximum to be expected under a program using the alternative method.

Maintenance Tasks Performed

The required annual maintenance for the assumed levee, including the waterward slope, the crown, and the

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landward slope, was assigned to the various units, recognizing the seasonal nature of some work items and the special capabilities involved.

Maintenance work performed by the proposed system was assumed as follows:

1. Repair of slopes and bank protection. This work would be done intermittently on a year-round basis, as the need arises and the more seasonal workload permits, and would involve both the barge and the LCM's, depending on the size and location of the problem.
2. Watering. Watering would be done during the summer months only, and would be required principally where new grasses or other ground cover plants were being started. Watering could be done from the barge or the LCM's.
3. Burn-off of grass. Burning of grass would be required where rank stands of annual plants prevent adequate inspection and rodent control measures. This would involve portions of the waterward slopes and much of the landward slope, but would not usually involve the same areas that require watering. Burning would be done during late summer and early fall, and either the barge or the LCM's could provide water for fire control.

Youth Authority wards could be used profitably for work of this type.

4. Tree trimming. The removal of undesirable trees, tree limbs, and tree tops would be done principally during the winter season when the leaves are off. Most of this work would be done by the barge because of the longer booms with larger load capacity and because of the availability of a chipper and burner for disposal.

   It was conservatively assumed that this work must be completed in a three-month period. If experience showed that tree trimming could be carried on during more than a three-month period, the proposed units could cover a larger area and make more efficient use of the equipment.
5. Brush cutting. Brush cutting would be done throughout the year, but a major portion might be done during the winter months concurrently with trimming. The LCM's would carry on this work during the winter, but the barge could assist during other seasons. Some portions of this work would

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involve hand labor as a supplement to the equipment operation. This labor could be provided by the Youth Authority wards.

6. Selective spraying. Spraying to eliminate undesirable species or control excessive growth would be done principally during the spring and summer. Some of this work could be done from the barge while other work is in progress, but much of the spraying could be done from the more mobile LCM and truck units.

7. Rodent control. Some rodent control would be carried on in conjunction with other work on a fairly continuous basis, but the major share would be done in the fall, using principally the LCM and truck units. Extra hand labor from the proposed Youth Authority Training Center at Stockton could be used profitably during the peak season.

The problem of rodent control may justify additional study by biologists in the Department of Fish and Game to develop better methods. If such a study is undertaken, a check should be made with the U. S. Department of Agriculture and the University of California Agricultural Extension Service to take advantage of their research in this area.

8. Inspection. Inspections would be made by all units as they move through the area on various assignments, but complete inspections should be made during the spring after the flood season, and during the fall after the burning and before the winter rains. The bulk of the inspection during the spring and fall peaks would be done from the LCM and truck units. Cleanup of trash from recreational use could be done in connection with the inspection.

9. Flood fighting. All units could be available for flood fighting when needed, but the LCM-truck units would probably be the most useful except in special cases. This operation could include removal of vegetation where required as well as transportation of equipment, supplies, and personnel. The availability of crews from the Youth Authority Training Center would be a highly valuable adjunct to this equipment and the permanent personnel.

Optimum size of an initial group

The peak seasonal requirements for equipment and for skilled personnel were evaluated in the light of the magnitude of various tasks, the seasonal limitations and the suitability of equipment. It was decided that most of the tree trimming

should be done from the barge and during the dormant season, estimated at three months. On this basis, tree trimming was determined to be the critical task and the capability of the group was limited to the miles of levee that could be covered during the three-month period using the barge, with only minor assistance from other equipment. It was estimated from manpower studies that three LCM's, with lesser use of the barge, could perform the other tasks on the same mileage of levee during the balance of the year.

Efficient use of the barge for an operation such as tree trimming would require six men, but some other operations would require only two men. The LCM's would require a two-man crew each. The optimum size of a crew was established as eight men. This includes a maximum of six on the barge or two each on the LCM's, and includes two extra men for overlap of equipment use, replacement during personnel leaves, and maintenance work.

It will be noted that all of the equipment units would have a rather high percentage of idle time; however, the annual cost of idle equipment is a minor factor compared to labor costs. As a result, the group was planned to make maximum use of personnel rather than equipment. The "idle" time would also allow for maintenance and repair of equipment.

If experience shows that tree trimming can be done efficiently during more than a three-month season, it may be possible to add more men and make more efficient use of the equipment without wasting manpower.

Costs for the proposed initial maintenance group

The initial cost for a completely equipped self-propelled barge and the smaller support barge is estimated to be $275,000. The initial cost for three LCM's with trucks and hydraulic cranes or aerial platforms is estimated to be $252,000 giving a total equipment cost of $527,000. The breakdown of these figures is given in Table 2.

Careful estimates of the seasonal limitations and time requirements for each of the work items listed under Maintenance Tasks Performed indicate that the proposed group could adequately maintain about 100 miles of major levees with the eight full-time men. This indicates that the initial investment in equipment would be about $5,300 per mile of major levee to be maintained.

Annual costs for larger levees

Annual costs for the larger levees were estimated by using the same distribution of tasks as that used to determine equipment requirements. Total annual costs, including operation, maintenance, replacement of equipment and overhead, were estimated to be $1,900 per mile. Table 3 gives the total annual costs for 100 miles and Table 4 gives a breakdown of these costs by task on a per-mile per-year basis.

TABLE 2

ESTIMATED CAPITAL COSTS OF EQUIPMENT FOR PROPOSED INITIAL MAINTENANCE GROUP

BARGES

Self-propelled Barge		$ 60,000
Heavy-duty Crane		50,000
Aerial Platform		15,000
Hydraulic Crane		5,000
Chipper		6,000
Burner		3,000
Power Unit		25,000
Drive Unit		25,000
Crew Quarters		10,000
Miscellaneous Support Equipment		25,000
Subtotal		$ 209,000
Support Barge		20,000
Subtotal		$ 229,000
Contingencies @ 20%		46,000
CAPITAL COST OF BARGE & EQUIPMENT		$ 275,000

LCM's

LCM's	3 @ $50,000	$ 150,000*
Trucks	3 @ $10,000	30,000
Subtotal		$ 180,000
Hydraulic cranes	2 @ $ 5,000	10,000**
Aerial Platforms	2 @ $10,000	20,000**
Subtotal		$ 210,000
Contingencies @ 20%		42,000
CAPITAL COST OF LCM's AND EQUIPMENT		$ 252,000

*Will be much cheaper if available from war surplus
**An extra unit is included for versatility

TABLE 3

ESTIMATED ANNUAL COSTS FOR PROPOSED INITIAL MAINTENANCE GROUP

Barges		
	Replacement, normal maintenance, etc.	$ 27,500
	Operation	9,000
		$ 36,500
LCM's		
	Replacement, normal maintenance, etc.	$ 22,000
	Operation	6,500
		$ 28,500
Total Annual Equipment Costs		$ 65,000
Labor Costs (8 men, including overhead)		$ 120,000
Supplies		5,000
Total Annual Maintenance Costs (100 miles of major levee)		$ 190,000

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TABLE 4

ESTIMATED ANNUAL MAINTENANCE COST PER MILE OF LEVEE FOR PROPOSED ALTERNATIVE METHOD

	$ 10 per mile
Inspection	620
Repair of bank protection	110
Watering grass	50
Selective spraying	40
Fertilization	210
Grass burnoff	210
Brush cutting and plant replacement	260
Rodent control	390
Tree trimming	$ 1,900 / levee mile

Note: These costs include supplies, operation, maintenance, and replacement of equipment as well as overhead expense

Costs for Minimum Freeboard Levees

The costs developed in the previous section represent a comprehensive program on large levees, with considerable attention to developing natural beauty on the levees as well as to the basic purpose of flood control. Levees in the lower Delta typically have little freeboard and are not susceptible to extensive reconstruction or re-sloping. Introduction of new species of trees is not feasible in many cases, so the maintenance program would consist principally of inspection, selective spraying, trimming and removal of undesirable native growth. The cost of an alternative maintenance program for this type of levee has been roughly estimated at $500 per mile per year, and costs throughout the Delta area would vary all the way between this figure and the $1,900 per mile for larger levees.

Single Agency Responsibility

The economics of specialized equipment can be realized only if equipment is operated on a continuous basis by properly-trained personnel. It is proposed that the program of uniform maintenance be undertaken by a single group occupied continuously and solely with levee maintenance and charged with the responsibility to first, maintain the integrity of the levees system as flood protection structures; and second, preserve and

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enhance the aesthetic, wildlife and recreational values of the area to the highest degree practicable.

The State Reclamation Board is now charged with responsibility for approval of construction work or encroachments on levees within the flood control project or which affect the project. This agency also has provided the assurances for maintenance required in connection with the Project Levee System and is responsible for initiating the measures necessary to improve unsatisfactory maintenance. It is proposed that the responsibility for implementation of policy, administration and performance of the single agency levee maintenance program using alternative methods be assigned to the State Reclamation Board.

Policy Formulation

The responsibilities and powers of the Board should be broadened to the extent that, while the primary responsibility is clearly understood to be flood control, the Board would be assigned the duty and given the authority to implement policies for levee construction and maintenance for the preservation, restoration and enhancement of scenic beauty, wildlife and recreation.

To accomplish this objective, the Board's membership must be broadened to include representatives of wildlife and recreational interests in addition to those concerned primarily with flood control.

Administration

The technical staff of the State Reclamation Board should include experts in landscape technology, wildlife management, plant biology and recreation to assist in interpretation and evaluation of the various problems, conflicts and benefits in order to facilitate the application of the policies set by the Board. These people should be contracted to the Reclamation Board from the State agencies representing their disciplines rather than being employees of the Board, so that they truly represent their respective specialties.

Project formulation

Plans for all investments and projects under consideration should be referred to the various county, State, and federal agencies concerned with flood control, water development, wildlife and recreation with a request for their comments.

Operation

The maintenance crews should be advised by people competent in plant biology, wildlife management and recreational problems in order that complete and competent information is available for administrative and policy decisions.

Proposed Uniform Maintenance Program

It is concluded that preservation of the scenic and wildlife values of the Delta and utilization of the recreation potential without jeopardizing the flood control depends on

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establishment of an adequate Uniform Maintenance Program. This program would apply the proposed alternative maintenance method under a single agency and would allow retention of trees and shrubs on the levees. It would also provide the necessary surveillance and control.

Detailed studies have been made of the tasks that must be performed, the equipment and personnel necessary to perform these tasks, and the costs entailed for reaches of representative levee. These studies are only on paper, however, the method is novel and use of the equipment is unique. Estimates of capabilities and costs should be considered preliminary until actual experience has been gained. The program should be initiated on a modest scale and expanded as experience is accumulated.

Recommended initial scope

A balanced group of equipment and personnel was estimated to be capable of maintaining about one hundred miles of levee. It is recommended that the initial scope of the program include not more than the one hundred miles and preferably somewhat less. This limitation is especially important until the personnel gain experience in the use and capabilities of the equipment. The density of trees and shrubs and the required treatment have been estimated on a preliminary basis, but the optimum program to assure flood protection and, at the same time, maximize other benefits must finally be determined through experience.

This initial program might well include some of the levee mileage now in State maintenance areas and should certainly include substantial reaches along a major stream channel, but the actual selection of levees to be included should be left to the agency in charge. The suitability for inclusion in an initial program will depend on the location and type of levee, the condition of the levee, and the attitude of the local district or landowner.

Estimated costs for an initial program

The cost of equipment for a maintenance group suitable for an initial one hundred miles of levee has been estimated at $530,000, or $5,300 per mile. There will also be costs in assembling the group, training personnel, etc., so the total capital investment for an initial group is estimated at $550,000 or $5,500 per mile of levee included.

The estimated annual costs of maintenance by the alternative method for levees along major stream channels are $1,900 per mile; and for levees with minimum freeboard, $500 per mile. The initial program should include a predominance of the larger levees, and an average annual cost of $1,500 per mile should be reasonable. These costs are based on 1965 prices.

Based on an average annual cost of $1,500 per mile, the annual costs for the initial portion of the Uniform Maintenance Program would be $150,000.

Estimated costs for a full Uniform Maintenance Program

As experience is gained with the alternative maintenance method, and as levees are rehabilitated under the bank protection and flood control projects, the Uniform Maintenance Program could be expanded and should ultimately include at least 665 miles of levees in the Delta. These levees would vary all the way from the large levees on major stream channels to minor levees on backwater sloughs. Assuming that the average annual costs are $1,200 per mile, the ultimate total annual costs for the program would be about $800,000.

The capital investment for maintenance groups to operate the ultimate program, estimated at $5,500 per mile, based on 1965 prices, should total about $3.7 million, including the initial group.

Proposed Management of Vegetation

Annual or perennial grasses, and other low-growing ground cover plants are completely compatible with levee maintenance for flood control and are permissible on either the land-side or water-side levee slopes without any special maintenance precautions. This growth is, in fact, encouraged in the federal regulations for maintenance of flood control project levees.

The discussion of proposed management of vegetation is concerned with trees and shrubs, which are not entirely compatible with present maintenance methods and require

special precautions to assure adequate safety for flood control. Furthermore, because emergency patrolling during flood seasons depends primarily on a clear view of the land-side slopes of the levees, the recommendations for use of trees and shrubs will be limited to the water-side slopes, the berms, and channel islands.

Trees and shrubs on berms and channel islands present no special problems for maintenance and flood fighting in most cases, so any special construction or maintenance procedures would be for the purpose of preserving and enhancing the vegetation rather than to assure flood protection. There is no requirement for limitation of density or location for trees and shrubs in these areas unless channel capacity is an initial factor. This is not generally a problem in the Delta, so any program to improve scenic beauty, wildlife habitat, and recreational values should take all possible advantage of the berms and channel islands.

The use of trees and shrubs on the water-side slopes of levees must represent a compromise between the wild growth that may be ideal for scenic beauty and wildlife, and the clear slopes that might be desirable for maintenance purposes. Full advantage should be taken of the capability for inspection, repairs, and maintenance among trees and shrubs under the proposed Uniform Maintenance Program, but this capability should not be exceeded. The recommendation for management of vegetation on levee slopes is limited to those

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reaches that can be included in the proposed maintenance program.

Any program for management of vegetation must first assure the flood control safety of the levees, and beyond that should provide the maximum possible benefits for scenic beauty, wildlife and recreation.

Requirements for Wildlife

Levee vegetation is most important to non-game wildlife, and this is considered to be its primary value, from the standpoint of overall wildlife conservation as well as for aesthetic and recreational benefits.

For the majority of the bird species, there should be at least 85 percent total ground coverage with 35 percent in trees and shrubs, 25 percent in taller weeds and the remainder in grass. For many wildlife species, there should be intermittent patches of relatively dense shrubs. The spacing of these clumps should not be more than one-fourth mile for most wildlife and should be about half that distance for some species, such as quail.

There should be a variety of trees and shrubs to provide food, nesting potential and year-round cover. Trees with spreading crowns are generally the most desirable, and the inclusion of some conifers is recommended. Shrubs should include evergreens, be non-spreading, thick-branched and thornless, and should provide some wildlife food.

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Requirements for Scenic Beauty and Recreation

The requirements for wildlife are also generally adequate for aesthetics and recreation. The positioning of trees on the levees should vary, with some near the toe and others distributed on the slope at least up to the crown. The spacing of trees along the levees should be irregular, so that the overall effect is of wooded areas interspersed with open, grassy slopes. Grasses or other ground cover plants should be encouraged to cover revetment on the levee slopes.

Typical Use of Vegetation on Levee Slopes

The use of vegetation on levee slopes would vary greatly depending on the location, material, and the depth or normal freeboard, or exposed slope. At one end of the scale are the levees along the major flood channels, with extensive slopes exposed above the normal water surface and constructed of predominantly inorganic material. At the other extreme are the peat levees in the central Delta, where critical high water periods are more the result of high tides and winds than flood flows, and the exposed slope or freeboard is minor, even at low water stages.

The treatment that can be justified, or that is even possible, is very different in the two extreme cases, and levees throughout the Delta vary all the way in between.

Levees on Major Flood Channels

The levees along the major flood channels justify more detailed planning for the use of vegetation; the results to be achieved are warranted. They also are exposed to higher velocities during flood flows so that the means for preventing and correcting erosion problems is of paramount importance.

The trees and shrubs should be selected for the best characteristics of stability and hardiness with secondary consideration of wildlife suitability and attractiveness. The locations of the trees should vary from a little above normal water surface to a little below the crown and the spacing should be irregular. Some trees should be replanted on reveted slopes, and particular care should be taken under the Uniform Maintenance Program to repair any displacement of rock that occurs due to the growth of the trees.

Grasses or other ground cover plants should cover the slopes between trees and shrubs, with particular attention to covering the revetted areas. The species best suited for this purpose will be selected during the current Pilot Levee Maintenance Study; but where new species are not suited, the growth of native grasses should be encouraged.

Central Delta Levees

Many levees in the central Delta have only a few feet of freeboard, even at low water. These levees do not have

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enough root zone to support the larger trees and do not provide enough space to justify an expensive program. The vegetation on this type of levee should consist of native trees, shrubs and grasses, with encouragement of such species as Alder. Only the clearing and trimming which is required for inspection and maintenance and to prevent toppling should be practiced.

The peat levees do not have the structural stability to permit extensive reconstruction, but a program of experimentation has been proposed to provide revetment in the normal surface zone.

Suitability of Vegetation

The criteria for selecting suitable vegetation for levee slopes and berms includes compatibility with flood control and their contributions to scenic beauty, wildlife shelter and food, and recreational enjoyment. The vegetation must be able to withstand the drought conditions in summer and yet not be seriously affected by periods of submersion during flood seasons. Resistance to disease is a necessary characteristic from both the flood control safety standpoint and consideration of maintenance costs.

A strong root system is desirable for stability during floods and high winds, and generally indicates a hardier plant in other respects. Moderate heights and top weights are desirable, again from the standpoint of stability, but, if all other

aspects are desirable, this objective can be achieved by topping and trimming.

Scenic beauty requires some variety in species and leaf colors; also, shape and flower characteristics are important. The location and spacing of plants may be as important as their characteristics. Wildlife requires a variety of species to meet the food and shelter needs and also requires some grouping of trees and shrubs at intervals to provide refuge. Recreation requirements include shade and pleasant environment. Both recreation and scenic beauty requirements are completely compatible with wildlife.

No work was done on the suitability of various grasses, as the final recommendations of the current Department of Water Resources Pilot Levee Maintenance Study should be followed when selecting low ground covers.

The following points should be considered in any planting or selective clearing program.

1. All tree and shrub classifications are based on mature growth under favorable conditions.
2. No tree will develop a very strong root system if growing too close to water, as roots of most species tend to stop growing when a sufficient water supply is available, or, at best, to develop a shallow, plate-like root system.
3. Thick, bushy evergreen trees and shrubs are the best for most species of wildlife, but some deciduous trees are satisfactory.

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4. Tree topping will make the tree bush out. This provides excellent nesting cover for many song birds.
5. When the determination is made as to which plants should be removed during a selective clearing operation, a priority should be established on shrubs and trees to be left standing. This would necessitate a man familiar with wildlife needs and the different plant species found on Delta levees as part of the maintenance supervision.
6. There must be combinations of several trees and shrubs for maximum wildlife benefits. No single species, even though in itself it provides good wildlife habitat, is satisfactory.
7. Fast-growing trees may be used initially, even though the characteristics at full growth are undesirable. These trees may then be eliminated when slower-growing species can replace them.

Proposed Public Use of Levees

The Delta includes vast areas of water which are completely open to public use, but practically all of the

levees bordering the waterways are private property. This area has a tremendous capacity for recreation and has unique characteristics that cannot be replaced, either now or in the future. However, the full recreational potential cannot be realized without the public use of levees and channel islands along with the waterways.

Studies indicate that the recreational demand in the Delta will exceed the capacity by 1990. The California voters, in passing the State Beach, Park, Recreational, and Historical Facilities Bond Act of 1964, recognized the importance of providing now for the aesthetic and recreational needs of the future. The present heavy use of this area testifies as to its importance today.

When the potential use of the levees for land-based recreation is added to the increased usefulness of the waterways, the assurance of public access rights is probably the best buy in recreation available today for the public dollars.

A program to provide for public use of the levees must first assure the flood control capability of the structures and, second, provide the maximum aesthetic, wildlife, and recreational benefits compatible with flood control. This program must include many Non-Project Levees in addition to those now included in the various public works projects.

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To achieve the maximum benefits for scenic beauty, wildlife and recreation, modified methods of maintenance must be applied so that vegetation can be retained on the levees. First, however, many levees should be rehabilitated so that these maintenance methods can be applied without jeopardizing flood control. Finally, public access must be provided for, zoning must be planned, and the necessary policing must be provided to assure the orderly development and optimum use of the area.

Rehabilitation of Levees

Rehabilitation of many levees, particularly those in the Non-Project category, is a necessary prerequisite to their inclusion into the proposed Uniform Maintenance Program which will provide for retention and control of vegetation. The proposed Sacramento-San Joaquin Delta Flood Control Project, now under study by the U.S. Army Corps of Engineers, is the logical means for achieving this objective on the present Non-Project Levees.

The proposed project could include all of the levees of the Delta not presently involved in a public works program, where engineering feasibility and economic justification can be demonstrated. Any levees that cannot meet these criteria should not be included in the Uniform Maintenance Program.

It is recommended that the U.S. Army Corps of Engineers

be urged to press their study of the Delta Flood Control Project and that they be requested to coordinate their planning efforts with all affected State and local agencies and special-interest groups as well as with the U.S. Fish and Wildlife Service and the U.S. Bureau of Outdoor Recreation. Only in this manner can full consideration be given to incorporating all the possible benefits to scenic beauty, wildlife and recreation into the project.

Public Ownership

Public access to the levees for recreational purposes is essential for the realization of the full potential of the Delta. The preservation and enhancement of scenic beauty and wildlife habitat will require the application of modified maintenance methods on a uniform basis. Finally, the general use of the levees by the public will require strict control of encroachments, the enforcement of zoning regulations, and policing to control vandalism, littering and sanitation.

All of these purposes are best served by public ownership of all those levees that are of value to scenic beauty, wildlife or recreation. This may exclude levees, or sections of levees, that are now highly developed with homes or businesses that are compatible with the eventual zoning of the Delta.

Although not strictly a part of this study on levees,

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the channel islands in the Delta can be a very significant adjunct to the improvement of the levees. Many of these islands now support trees, and parts of others could be raised by dredging so that trees could grow. These could serve as wildlife habitat and recreation spots in themselves and would greatly enhance the scenic beauty and recreational value of the waterways. These islands should be purchased before their usefulness is ruined by unsuitable developments.

Present Project and Direct Agreement Levees

These categories include about 385 miles in the flood control projects and 80 miles in Direct Agreement Levees, including those along the Stockton ship channel. Rights-of-way for Project Levees have been secured by the State Reclamation Board; about 15 miles by fee title and about 370 miles in the form of easements. The Direct Agreement rights-of-way were mostly in the form of construction easements, involving no access rights after the project completion.

Some of the present Project Levees are destined for further work under the Bank Protection Project now in progress and all but about 70 miles will eventually require similar work. Purchase in fee title of the levees involved should be a prerequisite to any further work and should be included in the project cost. The outright purchase of the remaining 70 miles of levees in this category should be considered for assurance of proper maintenance and enhancement of wildlife and recreation.

Present Non-Project Levees

All present Non-Project Levees that are eventually included in the proposed Sacramento-San Joaquin Delta Flood Control Project should be purchased in fee. That portion of the purchase price which would be required for rights-of-way would automatically be a part of the flood control project costs. Additional costs over and above the price of an adequate easement, if any, would be chargeable either as protection and restoration of wildlife habitat or enhancement of recreation.

Estimated Non-Flood Control Costs for Levee Purchases

Proposed purchases of levees would include up to about 370 miles of levees within existing flood control projects. Additional construction work under the present Bank Protection Project is planned for 15 miles of these levees, and similar work will be required on most of the remainder. Work is completed on about 70 miles of the present Project Levees.

In the Delta, there are about 80 miles of levees which have been constructed or reconstructed under direct agreements with the U.S. Army Corps of Engineers and on which no additional work is planned. Generally, there are no rights-of-way existing on these levees.

There are now about 550 miles of Non-Project Levees in the Delta, of which about 200 miles could qualify under the

proposed Delta Flood Control Project, and rights-of-way would be required. The remaining 350 miles on Non-Project Levees should not be considered for purchase, nor for inclusion in the Uniform Maintenance Program until the need is proven and their suitability can be carefully evaluated.

Table 5 shows the estimated separable, non-flood control costs for purchase in fee of these levees. Purchases in connection with flood control work are assumed to be part of the project costs.

TABLE 5

ESTIMATED NON-FLOOD CONTROL COSTS
FOR LEVEE PURCHASES

	Miles	Costs
Existing Project Levees		
Construction completed	70	$250,000
Additional construction planned	300	In flood control project costs
Now owned in fee by State	15	Nil
Direct Agreement Levees	80	$450,000
Existing Non-Project Levees		
Proposed Delta Project Levees	200	In flood control project costs
Remaining Non-Project Levees	350	Not included in proposed program
Totals	1,015	$700,000

Cost Allocations

A program to insure the flood protection of the Delta, and, at the same time, preserve and enhance the scenic beauty, wildlife resources and recreational potential in the area, will involve annual maintenance costs in excess of those required for flood control purposes only. Before such a maintenance program can be applied throughout the Delta, however, many levees will require rehabilitation to bring them to a condition that can be satisfactorily maintained. Also, there will be substantial costs in staffing, equipping and training of the groups to initiate the Uniform Maintenance Program.

Satisfactory performance of the maintenance and proper control of encroachments can best be insured by acquisition of the levees in fee. Because full realization of the wildlife and recreational potential of the area depends on public ownership of the levees and channel islands, substantial costs for land purchases will be involved.

Levee rehabilitation, land purchases and initial costs of the Uniform Maintenance groups are defined as capital costs. Annual costs for the maintenance program include operation, maintenance and replacement of equipment, supplies, and labor costs, including overhead. Administration of the program is assumed to be a portion of the work performed by the responsible agency and no estimate of costs has been made for this item.

Where possible, allocation of costs for the total program should reflect the benefits for various purposes and to various groups or areas. The problems of assessing these costs to the various beneficiaries must also be recognized, as there is no useful purpose in proposing an intricate formula of allocations that cannot be practicably applied.

Rehabilitation of the levee system and application of the Uniform Maintenance Program will yield substantial benefits for flood control as well as for wildlife and recreation, but it must also be kept in mind that public use of the Delta waterways by commercial shipping and pleasure boaters is now causing substantial levee damage for which no public responsibility has been recognized. Preservation and enhancement of scenic beauty and wildlife certainly provides benefits to many residents and recreational users in the area. It also represents the conservation of resources with recognized statewide and national significance. Developing the recreational potential of the Delta will stimulate commerce in the Delta and the nearby communities but it will also constitute a unique and significant contribution to the total recreational resources of the State and of the Nation.

Detailed assessment of costs among recreational users, wildlife conservation interests, and beneficiaries of the commercial stimulus is not practicable. Only those capital costs that should not be charged to flood control have been

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considered, and the discussion of allocation for these costs is limited to the following:

1) Separation of costs that might be met under existing programs and presently proposed programs from those that will require initiation of new programs or special legislation.
2) Citation of the existing legislation under which federal participation is available.

The discussion concerning allocation of continuing annual costs for the Uniform Maintenance Program is limited to a tentative proposal for sharing between the State and local interests, and would be subject to review after a period of experience.

Capital Costs

Capital costs include land purchases, levee rehabilitation and initial investments in maintenance units.

The purchase in fee of levees involved with flood control projects is assumed to be a part of those project costs. This assumption includes the current Sacramento River Bank Protection Project, future bank protection work that will be required on Project Levees, and the proposed Sacramento-San Joaquin Delta Flood Control Project.

The purchase in fee of levees where no flood control work will be needed would require funding for the purposes of aesthetics, wildlife and recreation only. In the case of Flood Control Project Levees, this cost should only involve

the purchase of land rights underlying the existing easements. The entire value of the land would be involved when purchasing Direct Agreement Levees in fee.

The levee repairs, prerequisite to inclusion in the Uniform Maintenance Program, are assumed to be completed under the present Bank Protection Project, future bank protection work on Project Levees, and the proposed Delta Flood Control Project. Planning for much of this work is not as yet completed, and cost estimates are not available. The work would be justified on the basis of flood control and no funding for other purposes should be necessary.

Present maintenance work by the local interest is either done by contract or by using equipment and personnel from other operations on a part-time basis. The need for a large investment in special equipment and for staffing is not normally encountered. It has been recommended that the annual costs, which include maintenance and replacement of equipment, be shared by the local interests, but the large initial investment should be allocated entirely to public funding.

Table 6 shows the estimated separable, non-flood control capital costs for the proposed program.

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Table 6

ESTIMATED NON-FLOOD CONTROL CAPITAL COSTS
(Based on 1965 prices)

Levee purchases in fee (From Table 5)	$ 700,000
Levee rehabilitation in flood control project costs	
Maintenance units	
Initial group	550,000
Additional for proposed ultimate program	3,150,000
Total non-flood control capital costs	$ 4,400,000

Where federal participation is involved, it is assumed that flood control project costs could be assessed on the presently-accepted formula of two-thirds to the Federal Government and one-third to the State or local interests. Separable costs for protection and restoration of fish and wildlife habitat, under Public Law 85-624, the Fish and Wildlife Coordination act, should be included as a part of the project costs and shared on the same formula.

Separable costs for recreation enhancement could be included in federal projects under either Public Law 87-874, the Rivers and Harbors Act of 1962, or Public Law 89-72, the Federal Water Project Recreation Act. If the federal work in the Delta is defined as non-reservoir, local flood control projects, the costs could be borne entirely by the Federal Government under Public Law 87-874. If the Delta projects

cannot be defined as "local", Public Law 89-72 would apply and the separable costs for recreation enhancement would be allocated one-half to the Federal Government and one-half to the State or local interests.

Annual Costs

There would be continuing annual costs for the Uniform Maintenance Program, estimated at $1,900 per mile for major stream channel levees and $500 per mile for levees in the central Delta with minimum freeboard (1965 prices). The initial program, which would involve 100 miles, is estimated at $1,500 per mile because of a predominance of larger levees, but the ultimate program, which would involve a majority of the Delta levees, should average $1,200 per mile.

Estimate of present costs for levee maintenance, which are paid by the local property owners, vary from $1,100 per mile down to $200 per mile. These estimates are based on sparse data, and there is no way to evaluate whether they represent an adequate level of maintenance in all cases.

The sharing of costs between local contributions and public funds for the initial program should be negotiated for each reach of levee with the appropriate local interest. The agency responsible for the program should estimate costs for the particular reaches using the proposed alternative method; the local share should be one-half this amount unless evidence can be produced that total costs for

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adequate maintenance under present procedures would be less. The local share should be a flat annual cost per mile and any departure from the estimated total costs with the alternative method should be absorbed in the public share. However, the cost-sharing agreements should be made for a period not to exceed five years and should be subject to renegotiation as based on experience gained during the initial period. Table 7 indicates the estimated annual maintenance costs.

Table 7

ESTIMATED ANNUAL MAINTENANCE COSTS
(Based on 1965 prices)

	Miles of Levee	Average Annual Cost Per Mile	Total Annual Costs State	Local
Initial program	100	$ 1,500	$ 75,000	$ 75,000
Ultimate program	665	$ 1,200	$400,000	$400,000

It has not been assumed that the federal government would contribute to the continuing annual costs of the proposed program.

Financing

The rehabilitation required to put levees in a safe condition for incorporation into the Uniform Maintenance Program is assumed to be included in either the Sacramento River Bank Protection Project or the proposed Sacramento-San Joaquin Delta Flood Control Project. The financing should then be the same as for current U.S. Army Corps of Engineers work in the Delta. The acquisition of right-of-way

for this work should be by purchase in fee, and the costs should be included as project costs.

Purchases of other levees where rehabilitation is not required, and the initial investments to implement the Uniform Maintenance groups will require special financing.

The annual costs of the proposed Uniform Maintenance Program should be assessed in part to the local interests who are now responsible for maintenance. Their fair share of this cost has been estimated on a preliminary basis to be 50 percent. The remaining portion of these annual costs will require special financing.

Those costs which will require special financing represent benefits to residents and recreational users of the area. They also represent substantial benefits to wildlife conservation and to the preservation and enhancement of a unique recreational potential of regional, statewide and national importance.

Considering the impracticability of assessing the costs in detail to the various beneficiaries and the broad nature of many of the benefits, it is recommended that these separable costs be proposed for funding by special acts of the California Legislature and the United States Congress.

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CHAPTER V. DELTA AQUATIC PARKWAY SYSTEM

The economic and social development of the Central Valley has brought about land uses and water uses which require detailed manipulation and control of the rivers and accompanying natural areas. Pressures of urban, industrial and transportation growth continue to compete with, and force back the natural characteristics. These uses planned for individual or single purposes are in conflict with scenic recreation use of the natural resources. Proper planning which encompasses scenic-recreation considerations can provide for multi-use of the resource to meet all needs. This type of planning is well underway in our cities and many of our water development projects, but is relatively new to our highway and flood control programs. Efforts from all levels of government encompassing proper planning, zoning, acquisition, development and operation is needed to realize full utilization of the diminishing natural characteristics which are important to the people's well being and enjoyment.

Today, in the wake of what seems to be almost complete alteration of the Valley landscape, the opportunity still exists to conserve, enhance, and utilize at least a part of the original natural and scenic elements. This opportunity lies in narrow ribbons along the rivers and the Delta channels.

The Delta is the vertex of the Central Valley River System and logically should be the beginning point or merging point of any continual chain of developments throughout. Considering the total river system as the resources, the best method of relating its developments is by the establishment of a parkway system. Because the major resources are waterway related and much of the waterways are navigable, the parkway system could be traveled by both auto and boat and, in many instances, by foot, bicycle and horseback. In the Delta, portions of the parkway system would be traveled only by boat with facility developments oriented to boat use. Continual automobile access along these waterways has been deemed impractical and not in the best interest of the development of these specific waterways; however, this does not preclude auto access to and along certain sections of a parkway where adjacent land-based facilities might be located.

Possible parkways in the Delta have been identified and placed into two categories relative to the most important type of access which they can provide:

1. Auto and Aquatic Parkways where the major access would by by automobile and boat, and
2. Aquatic Parkways where the major access is by boat.

The parkways recommended for the Delta are shown on Plate 2 entitled "Major Areas for Future Recreational Development".

Sacramento River Auto and Aquatic Parkway

The opportunity exists to develop an auto and aquatic parkway from the Antioch Bridge over the San Joaquin River upstream along the Sacramento River. The parkway developments could be interconnected by the navigable channel and a scenic highway.

The 1963 State Legislature designated State Highway 160 along the Sacramento River as a scenic highway. To designate this highway as a parkway would necessitate control of commercial traffic and access. Along most of the river upstream of Rio Vista, a roadway of nearly equal standards parallels the state highway on the opposite levee. These parallel roads could provide the answer to traffic control problems relative to commercial traffic along the river which would have to be solved. The parkway route could alternate from one side of the river to the other to take full advantage of aesthetic and recreational opportunities and solve through-traffic problems. Below Rio Vista to the Antioch Bridge, present access is limited to a single roadway making traffic control more difficult; however, areas for parking, overlooks, and bank-side developments exist throughout this reach accessible from the main roadway. Construction of an additional roadway through this area should be considered.

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Of primary importance along the river is protection and enhancement of the river corridor which is the foundation for establishing the parkway. The construction and maintenance practices of the levees will have to be altered to enhance and maintain a quality of landscape and recreation opportunity to provide an outstanding travel experience. Additionally, proper control and management of the corridor must be established on a long-term basis to assure perpetuation of the established qualities. Public ownership of the levees and a uniform maintenance program as recommended in this master recreation plan should accomplish both of these objectives.

Improperly placed or incompatible developments at channel-side which could influence speed controls and hazardous congestion are problems to be reckoned with. Also, the river handles commercial barge traffic which is an important transportation link for petroleum products and farm produce. Commercial and recreation navigation on the river are not necessarily in conflict since sufficient water is available to support both activities concurrently.

Conflicts of use arising from boating activities occur in the Sacramento River as well as in all other Delta Channels. A common conflict of use is that caused by water skiing in areas also used for cruising, mooring and fishing. Proper

zoning of waterway use will be needed to minimize these conflicts. Waterway use zoning must also relate to channel-side developments which may influence or be influenced by activities in the adjacent water area.

The specific objectives of the Sacramento River Auto and Aquatic Parkway in the Delta should be:

1. To preserve existing scenic qualities along the river, considering flood control needs.
2. To enhance the scenic qualities along the river by replanting and maintaining vegetation on the levees and berms as recommended in this master recreation plan.

   The object here is not to necessarily plant the entire length, but to create a variety of scenic experiences along the river intermittently blending into sweeping views across the agricultural land. An additional benefit from the reestablishment of such an environment will be an improved wildlife habitat. The application of landscape improvement should consider travel on the water as well as by roadway.
3. To provide facility development in appropriate locations for the use and comfort of the parkway travelers.

   In addition to existing or proposed parks and recreation areas directly accessible from the parkway, provisions should be made for boat launching, parking, picnicking, trails, overlooks, sanitation and garbage disposal along the entire length of the parkway for both boat and car travelers.
4. To provide proper policing and maintenance of the parkway to assure public safety and area cleanliness.

The role of the Division of Beaches and Parks in the establishment of this parkway should be to recommend to the Legislature, pursuant to the California Parkway Act of 1965, its inclusion in a State Parkway System. Further, to design, construct, and provide or seek proper operation and maintenance of appropriate facilities under the provisions set forth in the California Parkway Act of 1965.

Cosumnes River Auto and Aquatic Parkway

An auto parkway, nearly 7 miles in length, is proposed in the Cosumnes River State Park or Recreation Project. The proposed principle use of the river channel through the project other than fishing is canoeing. Coupled with these features, an extensive trail system is proposed along the river. These uses could be considered along the river upstream

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from the project in establishing a parkway accessible intermittently by automobile and entirely by canoe, raft and trail. Such a parkway could originate in the Delta Meadows-Cosumnes River Parks and go upstream to Highway 49 approximately where the main river begins to fork into its upper watershed.

Beside the mere recreational enjoyment of traveling the parkway, its visitors could be made aware of the historical and natural significance of the region from the Delta to the heart of California's Mother Lode area.

Under present flow characteristics, navigation of the river channel is not possible for four to five months in the summer and fall from the edge of the Delta to above Michigan Bar. During the remainder of the year, the flow is sufficient to accommodate canoes, rafts and small boats.

Water releases from anticipated regulatory and water reclamation projects in the upper part of the Cosumnes River and on the South Fork of the American River can provide year-round flows to support aquatic uses throughout the year, thus enhancing the desirability of a river-long parkway.

The role of the Division of Beaches and Parks in establishing this parkway should be to determine the feasibility of including an extension of the parkway proposed in the Cosumnes River Project into the proposed State

Parkway System; and if it is deemed feasible, to pursue implementation of it under the provisions of the California Parkway Act of 1965.

San Joaquin, Mokelumne and Old Rivers Aquatic Parkways

Aquatic parkways along these rivers in the Delta should be established to preserve scenic values and recreational opportunities for the boating public. The routes selected for these parkways provide navigable water for all types of recreation craft and contain or provide direct access to the major portion of the mid-channel islands in the Delta.

The purpose of this aquatic parkway system would be to insure a scenic corridor which would link together major recreation areas and park developments throughout the Delta. Within corridors, along reaches between major developments, many opportunities exist for the creation of small beaches and day-use areas for the boaters' use. These opportunities should be grasped to provide boaters with proper facilities for their enjoyment and comfort as they use the parkway and for the protection of the overall parkway environment.

It is recognized that the San Joaquin River, like the Sacramento River, is an important commercial waterway serving the Port of Stockton. However, there would be no conflict of use provided facility developments were not

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located on shores directly exposed to the ship channel, particularly in the narrower reaches; and actual alignment of the parkway did not follow the ship channel itself. Commercial barge traffic, which occurs in the Mokelumne and Old Rivers, should not be of sufficient volume or frequency to be in conflict with a parkway concept. Developments along these parkways could be expected to include privately-owned service facilities which would serve boaters, i.e., marinas, boat berths and docks, fuel stations, restaurants, stores, launching ramps and boat rentals. These developments would usually be located at channel side, therefore influencing or be influenced by waterway use. It must be recognized that a proper plan of development should coordinate placement of channel-side improvements as well as mid-channel island facilities. A detailed land and water use plan for these parkways must be developed, adopted, and applied through zoning regulations to accomplish an effective plan of development. Additional conflict of interest arises over the recreational use of the bordering privately-owned levees. These conflicts could be reduced by public acquisition and maintenance of these levee lands or by control of use through zoning regulations. Certain allowances for reserved rights and activities relative to existing land uses will have to be recognized in such a plan; however, the overall concept will be served.

The specific objectives of the San Joaquin, Mokelumne and Old Rivers Aquatic Parkways should be essentially the same as those for the proposed Sacramento River Parkway, except the orientation of development, use and operation should be to boat travel.

Recommendations

It is recommended that the California Parkway Act of 1965 be amended to include aquatic parkways as well as automobile parkways, or that an aquatic parkway act be adopted which would make possible preservation of and proper development of navigable waterways in California which have important natural and scenic values. Such an amendment or act would apply to those waterways where recreation boating is of prime importance and those where boat access is on a par with land access.

The Department of Parks and Recreation should be given authority and funds to implement such a parkway system. Further, the legislation should authorize the Resources Agency Administrator to establish an advisory committee to assist the Department in developing a master plan of aquatic parkways in California and to coordinate the plan with California's automobile parkway system.

The legislation should provide means whereby the State could cooperate with federal, county and city agencies who have flood control or water development projects on recommended aquatic parkway routes to develop and enhance

recreational opportunities in connection with construction projects, and to provide funds and means to acquire, design, construct and maintain or seek a local or regional agency to construct and maintain the parkways or parts of the parkways.

Finally, it is recommended that the San Joaquin, Mokelumne and Old Rivers Aquatic Parkways be in the proposed State Aquatic Parkway System and that an auto and aquatic parkway system be established for the Sacramento and Cosumnes Rivers.

CHAPTER VI. STATE PARKS AND RECREATION AREAS

Projected urbanization of the Sacramento-Stockton-East Bay Metropolitan Area Complex indicates that the entire region surrounding the Sacramento-San Joaquin Delta will be engulfed in an urban surge within the next forty years. Except for small urban communities, the Delta will become a source of rural open space within this urbanizing region. The natural resources of this open space, i.e., waterways, good agricultural land, natural, semi-natural wilderness, and subterranean minerals are of great importance to the State of California and the whole nation.

There is a great demand for developing these natural resources for use and enjoyment by the public. In the realm of recreation, requirements are spiraling. In the year 1963, over 2.4 million recreation visitor days were spent in recreation activities in the Delta; by the year 1980, the demand has been estimated to be more than 12 million, the higher percentage of which will be for non-fishing activities such as boating, water skiing, swimming, picnicking, camping and hunting.

Facilities for outdoor camping and picnicking from a boat are practically nonexistent in the Delta even though there were nearly 300,000 non-fishing boat activity days spent in Delta waters during 1963. At present, there are no

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existing projects in the Delta to provide for broad outdoor water-oriented recreation.

In 1961, the "Sacramento River and Delta Recreation Study" identified several areas in the Delta which represent... "examples of widespread conditions and special sites with unique values". Illustrative plans were presented for seven areas to show recreation use, and preliminary cost estimates were computed. A study of these proposals served as a beginning point in identifying projects which might be included in the State Park System.

Other preliminary studies by the Division of Beaches and Parks, Department of Water Resources, Federal Agencies and Delta counties have pointed out the need for public participation in the provision of sufficient land and facility developments to meet the spiraling demands by recreation visitors.

To properly study the complex nature of the Delta to determine its State Park System potential, certain considerations and criteria were set forth. First of all, the Division of Beaches and Parks currently operates two State Recreation Areas in the Delta. These are at Brannan Island and Frank's Tract.

While Brannan Island has been developed to approximately 50% of its potential, Frank's Tract has no facility development at present.

The demand pressures for recreation facilities in the Delta are exemplified by the number of visitors to these units annually. During periods of peak use at Brannan Island in 1965, the demand was as high as five times greater than the design capacity of the facilities. The annual visitor attendance for Fiscal Year 1963-64 was over 168,000. This amount of use reflects an overall over-use of existing facilities of nearly 75%. Ultimate facility development for Brannan Island S.R.A. will ideally accommodate about 200,000 visitors annually.

Frank's Tract S.R.A., even without facilities, provides a much needed publicly-owned area which is visited by thousands of people. The operating staff of the unit maintains a running tabulation of those visitors who actually use the area for primitive camping and picnicking. Of 32 sites visited regularly on favorable warm days throughout the year, over 48,000 persons were counted during the 1963-64 Fiscal Year. One can only assume the added pressures which might occur if facilities were provided and known to exist by Delta visitors. Untold numbers of fishermen also visit Frank's Tract Lake annually.

The above figures indicate that about 10% of the total Delta recreation visitors had an opportunity to use facilities and areas provided by the Division of Beaches and Parks in the Delta during Fiscal Year 1963-64. However, the capabilities of these two units when fully developed could serve

only about 4% of the total annual Delta recreation visitors projected for 1985.

Other projects and studies which had to be considered included:

1. Plans for water resources development in the Delta
2. Plans for navigation and flood control projects
3. The Kellogg Project in Contra Costa County
4. The proposed Cosumnes River Division Project
5. Possible recreational development of the Central Valley river system
6. California's interstate freeway system, specifically the Westside Freeway
7. Recreation elements of the Delta County Master Plans.

An analysis of these projects and studies clearly indicated the State Park System should play an important role in preserving and developing the Delta's recreational potential.

Field investigations were made to select areas which would meet the State Park System's criteria. The four following areas were finally selected for proposed projects: the Meadows Area; the Cosumnes River Area; Frank's Tract and vicinity; and the Old River Islands Area. The four projects recommended in this report are shown on Plate 2. Detailed land use and facility maps of these proposed projects are shown in Appendix B of this report.

Early in the investigation, studies clearly indicated

the Delta Meadows and Cosumnes River Projects could logically be considered as one; however, a fine line of urgency to protect the "Meadows" from commercialization which threatened its natural and historical values lead to the decision to single out the Delta Meadows as a separate project.

Subsequently, the Delta Meadows Project was recommended for acquisition and development by the State Park Bond Act of 1964. It was approved and became part of the Division's current active acquisition program on July 1, 1965.

Meadows Project

The Delta Meadows Project totaling 1,265 acres is in the northeastern portion of the Sacramento-San Joaquin Delta which is within the recreation region known as the Great Valley. The project area is approximately 28 miles downstream of Sacramento, located just east of the Sacramento River. It encompasses portions of Snodgrass Slough and Lost Slough, and is entirely within Sacramento County.

Water access is by the Delta Cross Channel at Walnut Grove, the Mokelumne River and Snodgrass Slough.

Highway access is by Twin Cities Road, the Sacramento River Road, and State Sign Route 160.

Project Resources

The project area encompasses the last remaining remnant, of consequence, of the original Delta wilderness. In the heart of the area surrounded by several interlocking

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sloughways is a series of low eminences rising several feet higher than the average level of Delta land. The highest of the small hills is the site of extensive Indian burials. The entire area abounds with plant and small animal life including over one hundred species of birds.

Surrounding this prime resource are approximately 14 miles of navigable sloughways lined with overhanging vegetation and approximately 100 acres of undulating land currently under agricultural use. The entire project is buffered from outside activities, almost entirely agricultural, by large flood control levees. These levees and their water-side berms support lush vegetation which insulates and protects the scenic and natural environment of the area. The perimeter levees are included within the project boundary.

Many hundreds of boaters have found a haven in the "Meadows" area down through the years as evidenced each summer season when boats of all descriptions can be found traversing the waters of the many channels in the area, or anchoring on Snodgrass and Lost Sloughs. Even though most of the area is privately owned, the public has been allowed to use the "Meadows" area for boating, swimming, and primitive camping and picnicking. This access to the public has been made possible by the graciousness of the Locke family, principal owners of the area, and others owning land adjacent to the sloughways.

Project Objectives

The purpose of the project should be to preserve and interpret the unique and valuable historical and natural resources of the Delta Meadows and to obtain maximum recreational use consistent with preserving the natural and scenic environment of the area.

To determine the size of the project, consideration was given to the area needed for protecting the natural environment of the "Meadows". Thus, related scenic areas providing the most appropriate opportunity for developing recreation facilities were included.

It was found that the Delta Meadows Project offers exceptional opportunity for developing a unique recreation experience. Included in this experience is an exceptional opportunity for historic interpretation. Indian burial sites and the small Chinese town, named Locke, and located adjacent to the project, provide significant historical records. These examples of the Delta's historical past should be preserved for interpretation.

To determine the magnitude and importance of Indian and early white settler activity in this area, an archeological investigation on the project site should be undertaken before any construction of facilities begins.

The accepted use pattern in this area is heavier during the summer season with a somewhat lighter use during the rest of the year. Fishing, cruising and boating, in general, are popular in the Snodgrass Slough area because of the combined natural resources -- vegetation, water and wildlife -- which together create an environment of wilderness solitude. Boat camping and picnicking facilities will be popular in this area and the natural and historical values of the "Meadows" will be of interest to the visitors.

The proposed development of the Delta Meadows Project will include facilities for the following activities: camping, picnicking, cruising, swimming, fishing, riding and hiking, water skiing and historical study.

Table 8 shows the facility potential of the Meadows Project.

TABLE 8

FACILITY POTENTIAL

Camping	
Number of units	245
Estimated Annual Visitor Attendance	150,675
Picnicking and Other Day Uses	
Number of units	210
Estimated Annual Visitor Attendance	104,580
General Parking	
Number of units	180
Estimated Annual Visitor Attendance	72,000
Total Estimated Annual Visitor Attendance	327,255

Project Cost Estimates

The estimated costs of the Meadows Project are summarized in Table 9.

TABLE 9

PROJECT COSTS

Estimates of Direct and Indirect Capital Costs:		
Total Acquisition and Development including Planning and Engineering		$3,032,000
Facilities Construction:		
First Five-Year Period		$1,061,000
Maximum development assumed to be completed at end of next fifteen-year period		
Operation Costs (Ensuing Five-Year Period):		
Annual Visitor Attendance	154,730	
Annual Operations Expenditure		$ 125,000
Annual Gross Receipts		39,400
Net Annual Operational Cost		85,600
Cost Per Visitor Day	.55	
Operation Costs (At Maximum Development):		
Annual Visitor Attendance	327,255	
Annual Operations Expenditure		$ 164,948
Annual Gross Receipts		82,570
Net Annual Operational Cost		82,378
Cost Per Visitor Day	.25	

Cosumnes River Project

The Cosumnes River Project is also located in the northeastern portion of the Sacramento-San Joaquin Delta. The project encompasses land immediately north of the Mokelumne River near the mouth of the Cosumnes River and lands and waters all totaling 3,450 acres along the Cosumnes River up to Twin Cities Road, entirely in Sacramento County. Its western boundary is the eastern boundary of the Delta Meadows Project.

Good water access by way of the Mokelumne River from New Hope Landing, the closest existing commercial launching area, and the waterways throughout the Delta, provides the opportunity for persons traveling the Delta Waterways by boat to visit the lower or western portion of the project. Proper speed controls and clearing of debris from the river channels will make safe navigation possible for nearly all sizes and types of recreation craft using the Delta today.

Highway access to the project is by Franklin Road in a north-south direction and Twin Cities Road in an east-west direction. The adopted route of Interstate 5 passes through the western portion of the project area. Upon completion, this major freeway will provide an outstanding access to the project from urban centers throughout the valley and the entire west.

Project Resources

The Cosumnes River has its headwaters in the high Sierras

and terminates within the project area where it joins the Mokelumne River. It is one of the major streams draining southeastern Sacramento County.

Near the mouth of the Cosumnes River, approximately 2,000 acres of the total project area are in a near natural condition. Of this total, nearly 900 acres is open meadow land covered with Valley Oak, California Buckeye, Wild Rose, Coyote Brush, Poison Oak, numerous wild grasses and wild flowers.

The remainder of this 2,000 acres is lowland covered with riparian growth, very similar to that found in the interior part of the Delta Meadows Project. It consists mostly of Red Alder, Oregon Ash, Box Elder, Creek Dogwood, Wild Blackberry, Oak, Willow, Poison Oak, and many water-loving grasses and sedges. The vegetation grows very lush and dense creating a formidable yet scenic picture along the river channels. This natural growth of vegetation provides an outstanding habitat for over 100 wildlife species.

Clearing and reclamation for agricultural use of the lands adjacent to the river is now occurring at a rapid pace and threatens to destroy most of the natural riparian growth within the project area. Already, approximately 1,000 acres in the project area have been cleared and leveled for crop production or pasture use.

At present, there are no roads into the project area east of Franklin Road except for field lanes which

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accommodate farm equipment and utility developments. A narrow gravel and earth road leaves Franklin Road near the Mokelumne River bridge on Franklin Road providing access along the north bank of the river to the McCormack-Williamson Tract west of the project. This access must be honored, or another considered, in the development scheme for the project to service the agricultural industry on the tract.

Sacramento County's "Southwest Area Plan", dated May 11, 1964, delineates a major arterial road connecting Orr Road from the east across the project area to Bruceville Road to the north. The Sacramento County Planning Department has indicated that there is no need at present for this artery. It was recommended to provide an additional circulation route between Galt and Sacramento for anticipated future pressure; however, the route could change or be deleted depending on other circumstances of future land use in the southern part of the county.

During the summer months, the lower reaches of the Cosumnes River dry up. This occurs because of minimal runoff in the watershed during this period and diversions for agricultural and industrial use.

The tides of the Delta provide some water through the very lower reaches of the Cosumnes River from its mouth upstream for approximately 2 miles. Under existing conditions during the summer, approximately 3.5 miles of waterways in the western portion of the project are navigable at high tide and 2 miles at all times.

Cosumnes River Basin Proposal

In March of 1964, the U.S. Bureau of Reclamation presented a report on the feasibility of Water Supply Development on the Cosumnes River. The basic concept submitted in their report is a system of reservoirs to..."store and regulate unappropriated water in the Cosumnes River Basin" as the initial phase of the Bureau's Cosumnes River Division of the Central Valley Project. These features would be located in the Nashville-Irish Hill vicinity. It is planned that the initial features will..."also provide flood control, power generation, fish and wildlife enhancement, recreation development and water quality control".

The effect of the Bureau's proposal on the lower portion of the Cosumnes River, including the Cosumnes River Project, would be two-fold:

1. Flood control built into the project features will influence peak flows into the lower river channels to give a greater degree of protection against damaging flood flows in the project area.
2. Flow releases during the summer and fall months for the multipurpose nature of the Cosumnes River development relative to fishery enhancement, water quality control, and recreation improvement will provide usable year-round flows throughout the Cosumnes River Project area.

Under present concepts, planned releases would range

from 100 to 300 c.f.s. during the year. An optimum flow to support the planned recreational use of the Cosumnes River Project during summer months is estimated by the Division of Beaches and Parks to be 150 to 200 c.f.s. The Bureau of Reclamation should be requested to consider this amount during the period from April to October. From preliminary study, it is assumed that these releases are possible.

Auburn-Folsom South Unit

Another source for water releases into the Cosumnes River will exist with the construction of the Auburn-Folsom South Unit. A release of 150 to 200 cubic feet per second during the summer months from this canal into the Cosumnes River should be considered in the event the Cosumnes River Division Project does not become a reality.

Project Objectives

The project's scope is based on the concept that the resources of the Delta Meadows Project and the lower part of the Cosumnes River are closely related.

The demand for outdoor recreation facilities and the need to preserve the Delta resources emphasizes the need to consider the Cosumnes River Project as an opportunity to provide sufficient land to support land and water-based facility developments in harmony with one another. Coupled with the Delta Meadows Project, the Cosumnes River Project will provide protection against further deterioration of this outstanding and attractive Delta and Valley woodland. Therefore, the basic purposes of the Cosumnes River Project are:

1. To preserve the remaining natural areas along the lower reaches of the Cosumnes River and the

area between the mouth of the river and the Delta Meadows Project.

2. To manage the areas contiguous with the river in such a way as to reestablish a river-associated wilderness related to the Delta Meadows Project and a river-long parkway, cognizant of the following encroachments:

   a. Franklin Road will remain as a major thoroughfare to facilitate local traffic.

   b. The main north-south line of the Western Pacific Railroad crosses the project approximately 1/3 mile east of Franklin Road.

   c. The adopted route of Interstate 5 crosses the project approximately 1/2 mile west of Franklin Road.

   d. The proposed alignment of the Peripheral Canal crosses the project approximately on the boundary with the Delta Meadows Project.

   If the canal were constructed according to preliminary plans, access continuity between the Delta Meadows Project and the Cosumnes River Project would be via the Mokelumne River channel from Lost Slough. Present plans call for an inverted siphon to be constructed under the Mokelumne River channel to transport the canal water.

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3. To provide an opportunity for many and varied types of recreation experiences in spacious surroundings. Camping and picnicking facility developments should be, primarily, land based, associated with the water resources of the area for swimming, fishing, quiet boating, and canoeing for both individual families and organized groups.

The relationship of the project to the Westside Freeway (Interstate 5) provides an excellent opportunity for a "Wayside" development located near the Mokelumne River between Franklin Road and the proposed freeway. Access to the site is good and its inclusion in a larger recreation complex is very desirable for ease of operation and management.

The proposed development of the project will provide facilities which will include the following activities: camping, picnicking, swimming, boating, riding and hiking and fishing.

Two distinct features of the proposed use for the project are:

1. Approximately 8 miles of canoe trails plus approximately 120 acres of laguna water surface for canoeing and quiet boating.
2. Nearly 7 miles of auto parkway with parking facilities which can become a segment of a river-long parkway system.

Bicycling and hiking should be the major use of the trail system which would total nearly 30 miles; however, a portion of the trail system could be adapted to horseback riding.

The extensive trail system can be connected to those in the Delta Meadows Project, a Delta trail system along the Peripheral Canal, and the Sacramento County riding and hiking trail system. Those visitors who come to the project area by trail could use the facilities provided for picnicking and camping.

Table 10 shows the facility potential of the project and relates the number of units to estimated annual visitor attendance.

TABLE 10

FACILITY POTENTIAL

Camping	
Number of units	510
Estimated Annual Visitor Attendance	314,650
Picnicking and Other Day Uses	
Number of units	340
Estimated Annual Visitor Attendance	339,350
General Parking	
Number of units	490
Estimated Annual Visitor Attendance	196,000
Total Estimated Annual Visitor Attendance	850,000

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Project Cost Estimates

The costs of the Cosumnes River Project are su marized in Table 11.

TABLE 11

PROJECT COSTS

Estimates of Direct and Indirect Capital Costs:		
Total Acquisition and Development including Planning and Engineering		$8,022,000
Facilities Construction		
First Five-Year Period after acquisition		$3,231,500
Maximum Development assumed to be completed at end of next fifteen-year period		
Operation Costs (Ensuing Five-Year Period):		
Annual Visitor Attendance	365,040	
Annual Operational Expenditure		$ 154,200
Annual Gross Receipts		75,100
Net Annual Operational Cost		79,100
Cost Per Visitor Day	.22	
Operation Costs (at Maximum Development):		
Annual Visitor Attendance	850,000	
Annual Operational Expenditure		$ 262,100
Annual Gross Receipts		180,660
Net Annual Operational Cost		81,440
Cost Per Visitor Day	.10	

Frank's Tract Addition Project

In the spring of 1938 an island in the heart of the Sacramento-San Joaquin Delta known as Frank's Tract was inundated when its perimeter levees gave way to the combined forces of

high tides and heavy runoff from the Sierras.

The entire island except for a 290-acre peninsula at its western extremity (which remained dry) became a lake of 3,310 acres. Frank's Tract was subsequently acquired by the State as an addition to the State Park System.

The area was known as Frank's Tract State Park until 1963 when the California State Park Commission designated it as Frank's Tract State Recreation Area. Frank's Tract S.R.A. is located in the northeastern part of Contra Costa County, just south of the San Joaquin River. It is bounded on the north by False River; on the east by Old River and Sand Mound Slough; and on the south and west by Piper Slough. The flooded portion of Frank's Tract thus becomes an unusual feature in that it is a lake almost completely surrounded by water. The dry peninsula, known locally as Little Frank's Tract, is now essentially an island.

Public access to Frank's Tract S.R.A. is, predominantly, by boat from the surrounding waterways. Little Frank's Tract can be reached by a county-operated auto ferry from a ferry slip on the northeast tip of Jersey Island. Automobiles must be left behind, however, since vehicular roads have not been developed on Little Frank's Tract except for maintenance purposes.

Across Piper Slough to the south lies Bethel Island which can be reached by traveling 4½ miles on Cypress Road and Bethel Island Road from Highway 4, near Oakley. These roads are surfaced and in good repair. A growing resort

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community is located on the southern and eastern portions of the island.

Bethel Island Road continues north across the island for approximately 2 miles where it terminates at the extreme northern side of Bethel Island, directly across Piper Slough from Little Frank's Tract.

To the north of Frank's Tract, across False River, lies Webb Tract, a large island supporting intensive agricultural activities. Access to Webb Tract is also provided by the ferry from Jersey Island.

Considerations have been given to providing automobile access to Little Frank's Tract and Webb Tract from Bethel Island by a bridge across Piper Slough and False River. Studies have since concluded that such construction would be too costly and the bridge would interfere with navigation.

This report proposes additions to Frank's Tract State Recreation Area:

1. 740 acres on the north side of Bethel Island fronting on Piper Slough and directly opposite the dry peninsula of Frank's Tract State Recreation Area.
2. 460 acres on the southern side of Webb Tract which borders False River immediately north of Frank's Tract.

Project Resources

The major resource of Frank's Tract S.R.A. is the 3,310 acre lake and its perimeter levee remnants. The lake's depth fluctuates from three to ten feet at low tide and from nine to sixteen feet at high tide.

Frank's Tract Lake is one of the most popular fishing areas in California. Great numbers of striped bass, black bass, catfish and blue gill frequent the lake, and during shad and salmon runs fishermen have an additional treat.

Levee remnants around the lake perimeter form a line of long slender islands suitable for landing boats at many points. These levee remnants protect the sloughs surrounding Frank's Tract Lake from wave action generated on the lake.

Dredging and spoiling sandy material from the lake bottom to strengthen the levee remnants would provide additional areas suitable for water-side development along the shores of the lake. Vegetation on the levee remnants is extremely scenic and consists of dense stands of tules, willows, wild blackberry and similar growth.

Project Objectives

Problems due to insufficient land at Frank's Tract State Recreation Area have been a matter of concern to the State for some time. The additions being recommended will provide the solution to these problems.

The proposed additions to Frank's Tract State

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Recreation Area, properly developed, will include facilities for the following activities: camping, picnicking, swimming, riding and hiking, fishing and water skiing.

Access to a naturally maintained area on the peninsula would be by boat. To facilitate boat access, docking areas should be provided at locations where trail heads could direct visitors through a nature trail system. Additional ponding of water in the central portion of the peninsula could enhance the waterfowl habitat by accommodating a larger number of birds. The entire peninsula should be managed to accommodate all types of wildlife indigenous to the Delta. Close liaison with the Department of Fish and Game and the University of California should be maintained, thus assuring a program beneficial to both wildlife enhancement and visitor appreciation.

A riding and hiking trail head with overnight facilities should be a part of the Frank's Tract State Recreation Area. This trail head would be a valuable portion of the Contra Costa County riding and hiking trail system. In addition, a riding and hiking trail extending southward to the Peripheral Canal-Clifton Court Forebay facilities would connect with the Peripheral Canal trail system and provide trail access through the Delta to the Meadows State Park, the proposed Cosumnes River Project and the Sacramento County riding and hiking trail system.

A public services area is proposed to operate launching facilities, a boat and bicycle rental service, a snack bar and an excursion boat service. The latter could be scheduled to

transport visitors to points of interest in the Delta. The public services area could also provide an interpretive program for visitors.

Table 12 shows the facility potential of the project and relates the number of units to estimated annual visitor attendance.

TABLE 12

FACILITY POTENTIAL

Camp Sites (Auto Access Only)	
Number of Units	200
Estimated Annual Visitor Attendance	123,000
Camp Sites (Boat Access Only)	
Number of Units	200
Estimated Annual Visitor Attendance	123,000
Camp Sites (Auto & Boat Access	
Number of Units	150
Estimated Annual Visitor Attendance	92,250
Picnic Sites (Boat Access Only)	
Number of Units	125
Estimated Annual Visitor Attendance	62,250
Picnic Sites & Other Uses (Auto Access only)	
Number of Units	300
Estimated Annual Visitor Attendance	177,500
General Parking	
Number of Units	430
Estimated Annual Visitor Attendance	172,000
Total Estimated Annual Visitor Attendance	750,000

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Project Cost Estimates

The estimated project costs for developing the existing Frank's Tract State Recreation Area and the acquisition and development of the Frank's Tract Additions are summarized in Table 13.

TABLE 13

PROJECT COSTS

Estimates of Direct and Indirect Capital Costs:		
Total Acquisition and Development including Planning and Engineering		$8,136,000
Facilities Construction:		
First Five-Year Period		$2,453,900
Maximum Development Assumed to be completed at end of next fifteen-year period		
Operation Costs (Ensuing Five-Year Period):		
Annual Visitor Attendance	304,300	
Annual Operational Expenditure		$ 157,680
Annual Gross Receipts		71,210
Net Annual Operational Cost		86,470
Cost Per Visitor Day	.28	
Operation Costs (At Maximum Development):		
Annual Visitor Attendance	750,000	
Annual Operational Expenditure		$ 279,880
Annual Gross Receipts		169,715
Net Annual Operational Cost		110,165
Cost Per Visitor Day	.15	

Old River Islands Project

The Old River Islands Project is located approximately 2 miles north of Tracy. It is known locally as the Tom Paine Slough - Berverdor Island - Paradise Cut Area and is a part of the old Rancho El Pescadero in San Joaquin County. The total land and water area encompassed by the project is 980 acres; waterways total about nine miles in length.

Like the other projects recommended, access to the Old River Islands Project area exists for both automobiles and boats. Auto access to the area is by Tracy Road either from Tracy or from Highway 4 from the north. Good boat access by way of Grant Line Canal puts the project within easy reach of cruisers traveling the Delta waterways.

The route of Interstate 205, the link between Interstate 5 and 580, has been adopted on an alignment in an east-west direction, approximately 1½ miles south of the project. This portion of California's Interstate Freeway System will provide excellent highway access to the project from the San Francisco Bay Area and the Westside Freeway, Interstate 5 will provide additional access from Southern California.

Project Resources

Very few areas in the southern portion of the Delta provide attractive tree-covered lands adjacent to the waterways. However, the Old River Islands Project area

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contains groves of Valley Oak. The mid-channel islands and peninsulas in this project area are covered with small groves of large Valley Oak and native grass meadows. These groves and meadows provide beautiful and pleasant vistas along Old River and Tom Paine Slough. This area presents an aquatic and land environment ideally suited to picnicking, camping and general outdoor enjoyment.

The two largest islands within the project total some 255 acres and are presently utilized as crop lands. A third large island remains in a natural condition. The three major islands are relatively flat or gently sloping, ranging in elevations of approximately 5 to 10 feet above sea level.

The numerous smaller islands and peninsulas along Tom Paine Slough downstream to Tracy Road range in elevation of 5 to 10 feet or more above sea level. They are covered with Valley Oak groves and banks throughout. The understory growth in most cases is limited to native grasses. Most of these areas are presently used for grazing purposes.

The proposed project area also encompasses the portion of Grant Line Canal, levee to levee, from Salmon Slough downstream to Tracy Road. This reach of the Canal is bordered on the south by a band of land inside the levee some 200' wide. Dense vegetation covers the area, and an intermittent shallow channel parallels the Main Channel along most of its length. The elevations range from 5' above sea level to sea level; the higher area occurring at the eastern end of the reach.

The Old River Islands Project can be likened to the Delta Meadows Project in that most of the area is surrounded by large levees protecting the adjacent farm lands from high waters.

The levees, with some exceptions, are clear of trees. In some areas, significant amounts of berm separate the levee proper from the adjacent channel. In most places, these berms support large Valley Oaks.

The waterways winding through the proposed project area are popular fishing areas. The Grant Line and Fabian-Bell Canals are extensively used by fishermen during winter months. The channels in the proposed project area are navigable; however, navigation hazards exist in some channels. Some dredging and stream clearance will be needed to provide for safer boating.

Project Objectives

The major objectives of the Old River Islands Project are:

1. To provide a major recreation area in the southern part of the Delta which has outstanding scenic values and good highway access from the San Francisco Bay Area and other California urban centers.
2. To provide a major development at the upstream end of the Old River Aquatic Parkway. The project will serve as a destination point for the boating public traveling the Old River Aquatic Parkway.

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The project's location, with respect to the Bay Area and the San Joaquin Valley, warrants providing facilities for one day and weekend use.

The development of recreation facilities is proposed for the peninsulas and islands within the perimeter levees. A portion of the project area near the western end would facilitate auto access and administrative developments.

Proposed developments would include facilities for the following activities: camping, picnicking, swimming, riding and hiking, cruising and quiet boating and fishing.

Automobile access to several peninsulas would be provided and picnic facilities developed. A small public services area located to the west and opposite the large southern island would provide a snack bar and bicycle and small boat rental service. A bridge from this area would provide automobile access onto the large southern island to a launching area and to a 100-unit campground. This latter campground would also be accessible by boat.

The remainder of the project would be accessible by boat only and would contain facilities for picnicking and camping associated with anchorage sites.

Dredging across the central part of the northernmost island to form an irregular shoreline totaling approximately 1 mile would provide an excellent opportunity to establish protected areas for beaches and small boat and cruiser mooring. Sanitary facilities, tables and fire rings would be

designed for easy removal and storage from the flood zone.

A group area located in the extreme southwestern corner of the project could accommodate organized groups for daytime use. Appropriate facilities would be provided, including a docking area.

Bank fishing is very popular along Grant Line Canal with access from the adjacent levee road. The levee crown will support parallel parking alongside the road for this continued use. Improved trails to the water's edge, portable sanitary facilities, and litter cans should be provided to serve fishermen and properly maintain the levee slope.

A total of 9 miles of hiking and bicycling trails would be included in the project area. Three miles of trail would be related to boat access. The remaining 6 miles should be made directly accessible to connecting trails from the Frank's Tract State Recreation Area, the Meadows State Park and the proposed Cosumnes River Project. The proposed riding and hiking trail, along the Peripheral Canal, would ideally serve as a part of this connecting trail system.

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Table 14 shows the facility potential of the project and relates the number of units to estimated annual visitor attendance.

TABLE 14

FACILITY POTENTIAL

Camp Sites (Auto & Boat Access	
Number of Units	100
Estimated Annual Visitor Attendance	61,500
Camp Sites (Boat Access Only)	
Number of Units	75
Estimated Annual Visitor Attendance	46,125
Picnic Sites (Boat Access Only)	
Number of Units	190
Estimated Annual Visitor Attendance	94,600
Picnic Sites & Other Uses (Auto Access Only)	
Number of Units	140
Estimated Annual Visitor Attendance	55,775
General Parking	
Number of Units	230
Estimated Annual Visitor Attendance	92,000
Total Estimated Annual Visitor Attendance	350,000

Project Cost Estimates

Estimated project costs for the proposed Old River Islands Project are shown in Table 15.

TABLE 15

PROJECT COSTS

Estimates of Direct and Indirect Capital Costs:		
Total Acquisition and Development including Planning and Engineering		$4,261,100
Facilities Construction:		
First Five-Year Period after Acquisition		1,720,800
Maximum Development assumed to be completed at end of next fifteen-year period.		
Operation Costs (Ensuing Five-Year Period):		
Annual Visitor Attendance	229,650	
Annual Operational Expenditure		104,200
Annual Gross Receipts		47,875
Net Annual Operational Cost		56,325
Cost Per Visitor Day	.24	
Operation Costs (At Maximum Development):		
Annual Visitor Attendance	350,000	
Annual Operational Expenditure		137,800
Annual Gross Receipts		72,550
Net Annual Operational Cost		65,250
Cost Per Visitor Day	.19	

Recommendations

The Delta's outdoor recreation resource is of statewide significance and the necessity for preserving and developing these resources for Californians can be justified.

The proposed projects discussed in this report would further enhance the State's excellent park system and it is recommended that in addition to the Delta Meadows, the Cosumnes River Project, the Frank's Tract Additions and the Old River Islands Project be acquired and developed as a part of the State Park System.

Levees and berms are a significant portion of the lands included in all of the above-named project areas. These levees and berms constitute, to varying degrees, invaluable scenic and wildlife values and provide access to park lands from the adjacent waterways. Therefore, every consideration should be given to fee acquisition of levee lands within each of the proposed projects.

A major recommendation of this report sets forth concepts for multi-purpose levee maintenance and includes proposals for multi-purpose maintenance to be performed by a single State agency. Levee lands within park boundaries could be included in an overall maintenance program by contractual arrangement between the Department of Parks and Recreation and the levee maintaining agency.

Recommendations for financing and implementation follow.

Delta Meadows Project

The Delta Meadows Project was developed as a part of this Delta Master Recreation Plan Study. However, because of the urgency previously stated, the Meadows Project was recommended for acquisition and development with funds to come from the State Park Bond Act of 1964.

The project was approved by the Resources Agency Administrator and submitted to the 1965 session of the California Legislature. The Legislature and Governor approved the project and it was included in the Division of Beaches and Parks current acquisition program.

Bond funds will also be used to provide minimum facilities related to access, sanitation, utilities, and public safety. Continued development of the project is planned to be financed from the Division's Capital Outlay Budget Program.

The following table summarizes the type and number of facilities which should be provided in the first 5-year development program, the next fifteen years and the total.

TABLE 16
DELTA MEADOWS PROJECT
FACILITIES SUMMARY

Facility	First 5-Years	Next 15-Years	Total
Camp Sites (Boat Access)	130 Units	65 Units	195 Units
Camp Sites (Auto & Boat)		50 Units	50 Units
Total Camp Sites	130	115 Units	245 Units
Picnic Sites (Boat Access)	80 Units	30 Units	110 Units
Picnic Sites (Auto Access)	25 Units	75 Units	100 Units
Total Picnic Sites	105 Units	105 Units	210 Units
General Parking	80 Spaces	100 Spaces	180 Spaces
Launching Ramps	2 Lanes		2 Lanes
Bicycle & Hiking Trails	4 Miles	5 Miles	9 Miles
Nature Trails	1.5 Miles		1.5 Miles
Total Trails	5.5 Miles	5 Miles	10.5 Miles

The project will be administered as a State Park by the Division of Beaches and Parks. The project should also be considered as an area headquarters for the recommended Cosumnes River Project.

Cosumnes River Project

Immediate acquisition of the entire project area with State Park Bond funds or special legislative appropriation funds and matching PL 88-578 monies is recommended. Leaseback arrangements on approximately 500 acres of the project area for grazing use may be considered for up to 10 years terms; however, leasing of State Park lands is not practiced currently by the State Park System. In fact, the State Park Commission policy states,

"Grazing within park boundaries as a general rule is not to be considered compatible with park use".

Grazing arrangements on some of the open meadow lands would have three basic advantages in the implementation and operation of the project, particularly during the first 10 years after acquisition. First, the Meadows could be maintained in their natural pastoral character complete with grazing animals. A proper ratio of animals to available forage would continue to maintain the natural characteristics. Second, this use would create less hardship on adjoining ranchers who now use the area for grazing by allowing them to phase out their cattle grazing programs in favor of other activities and thereby reduce severance damages in acquiring the project. Third, funds procured from such leases could be returned to the fund used for acquisition.

An initial five-year development program should begin upon acquisition of the project. The first phase of development should provide access and minimum sanitary facilities. The first phase of development should be financed by bond funds, if acquired from bond funds. If bond funds were not available for construction, the program could be financed by normal budget procedures.

Table 17 shows the type and number of facilities which would be provided in the first 5-year development program, the next fifteen-years and the total.

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TABLE 17
COSUMNES RIVER PROJECT
FACILITIES SUMMARY

Facility	First 5-Years	Next 15-Years	Total
Camp Sites (Auto & Trail Access)	200 Units	310 Units	510 Units
Picnic Sites (Auto & Boat Access)	200 Units	60 Units	260 Units
Picnic Sites (Auto & Trail Access)		80 Units	80 Units
General Parking	215 Spaces	275 Spaces	490 Spaces
Small Boat Launching Area	1		1
Parkway	7 Miles		7 Miles
Trail System	12 Miles	18 Miles	30 Miles
Concession Area	Provided by Concessionaire		

The project should be administered as a State park or State Recreation Area by the Division of Beaches and Parks. The geographic relationship of this project to the Delta Meadows Project indicates that the two could be operated on an area concept with headquarters at the "Meadows" and secondary administrative areas in the Cosumnes River Project.

Frank's Tract State Recreation Area

It is clearly evident that both overnight and day use facilities oriented to boat use are needed at this unit now. The demonstrated demand and volume of use of the levee remnants around the lake indicates an immediate need to provide proper facilities for the health and welfare of visitors, and for protection and maintenance of the overall environment and recreational opportunities at the unit.

An initial development program on the existing unit, financed by the Division of Beaches and Parks Capital Outlay Construction Budget, should be undertaken immediately to provide access to organized use areas, sanitary facilities and public protection.

A high priority for acquisition of the recommended additions should be established at once to keep pace with the recommended initial five-year development program. This program must be accomplished to relieve the over-use of facilities at Brannan Island State Recreation Area and to satisfy the current demand of thousands at Frank's Tract State Recreation Area.

Several alternatives for acquisition and development are possible.

1. The 740-acre Bethel Island Addition could be considered a State Park Bond project to be fully acquired and initially developed with bond funds or special legislative appropriation funds used on a matching basis with authorized PL 88-578 monies. The Small Craft Harbors Revolving Fund should be considered for developing launching ramps and related boat facilities.
2. Acquisition and development of the 460-acre Webb Tract Addition could be facilitated if the U.S. Army Corps of Engineers adopts the State's recommended route for the Stockton Deep Water Ship Channel. The State could make this land available to the Corps for spoiling channel dredgings. In addition to raising the land elevations, the Corps could participate by developing

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recreation facilities which could be operated and maintained by the State as a part of the Frank's Tract State Recreation Area. Financing of this project is dependent upon the timing of the Deep Water Channel. It is assumed the channel construction would not occur within the next five years. In such a case, the present bond funds will probably be depleted indicating that other methods will have to be used, i.e., special legislative appropriation, Capital Outlay Acquisition Budget, or other sources not yet apparent. Further negotiations between the Department of Parks and Recreation and the U.S. Army Corps of Engineers should be continued and every effort made to effect a joint program.

Table 18 shows the recommended development program for the total Frank's Tract State Recreation Area project and relates the number of facilities to the initial phase, first five years, next fifteen-years, and the total.

TABLE 18
FRANK'S TRACT STATE RECREATION AREA
FACILITIES SUMMARY

Facility	Initial Phase	First Five Years	Next 15 Years	Total
Camp Sites (Boat Access)	50 Units		150 Units	200 Units
Camp Sites (Auto & Boat Access)			150 Units	150 Units
Camp Sites (Auto Access)		100 Units	100 Units	200 Units
Picnic Sites (Boat Access)	50 Units	75 Units		125 Units
Picnic Sites (Auto Access)		100 Units	200 Units	300 Units
Group Area		1 Each		1 Each
General Parking		250 Spaces	180 Spaces	430 Spaces
Launching Ramps		4 Lanes		4 Lanes
Bicycle & Hiking Trails		4.5 Miles	7.5 Miles	12 Miles
Nature Trails		5 Miles		5 Miles
Horseback Riding Trails			1.8 Miles	1.8 Miles

Under the recommended plan, the Division of Beaches and Parks would administer and operate the recreation area from a land based headquarters on the Bethel Island addition. The headquarters could feature a two-story tower overlooking the entire unit. The tower would contain offices and a viewing

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room for visitors at the upper level and operations center at a lower level. Smaller utility and service areas would be located respectively on the existing peninsula and the proposed island adjacent to the Deep Water Channel.

Old River Islands Project

The desirability of placing a high acquisition priority on this project is apparant. The benefits this project provides to the large population centers of the San Francisco Bay area and the San Joaquin Valley indicates that it ranks favorably in comparison with other projects being recommended in the Delta. It is recommended that the project be acquired with State Park Bond funds, or State Bond funds used on a matching basis with PL 88-578 funds or other funds made available through the Capital Outlay Acquisition Budget and/or special legislative appropriation.

A five-year development program should commence immediately upon acquisition of the project. Complete development of the project could probably be accomplished within twenty years of the beginning of the development program. It is assumed that development would be largely financed by the Division's Capital Outlay Construction Budget.

Table 19 shows the recommended total development program with the type and number of facilities related to the first five-year period after acquisition, the next fifteen years, and the total.

TABLE 19
OLD RIVER ISLANDS PROJECT
FACILITIES SUMMARY

Facility	First 5-Years	Next 15-Years	Total
Camp Sites (Boat Access)	75 Units		75 Units
Camp Sites (Auto & Boat Access)	50 Units	50 Units	100 Units
Picnic Sites (Boat Access	40 Units	150 Units	190 Units
Picnic Sites (Auto Access)	80 Units	60 Units	140 Units
Group Area		1 Each	1 Each
General Parking	230 Spaces		230 Spaces
Launching Ramps	4 Lanes		4 Lanes
Bicycle & Hiking Trails	4.5 Miles	4.5 Miles	9 Miles

It is recommended that the Division of Beaches and Parks administer the project as a State Recreation Area.

Table 20 summarizes the facilities and costs of all four Delta projects.

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TABLE 20
SUMMARY OF FACILITIES
DELTA STATE PARKS AND RECREATION AREAS

	DELTA MEADOWS	COSUMNES RIVER	FRANK'S TRACT & ADDITIONS	OLD RIVER ISLANDS	TOTALS	...S
Acres	1,265	3,450	4,800[3]	980	10,495	495
Waterways (Miles)	14	16	7 (Plus 3310 acre lake)	9	46	46
Facilities[1]						
Beach[2] (Acres)	1.5	2.5	3.0	0.5	7.5	7.5
Picnic Units	210	340	425	330	1,305	305
Camp Units	245	510	550	175	1,480	,480
Parking	180	490	430	230	1,330	,330
Trail (Miles)	10.5	30.0	18.8	9.0	68.3	68.3
Launching Ramps (Lanes)	2	1	4	4	11	11
Annual Visitor Days (20 years)	327,255	850,000	750,000	350,000	2,277,255	,255
Costs						
Total Acquisition & Development	$3,032,000	$8,022,000	$8,136,000	$4,261,100	$23,451,100	,100
Annual Net Operation	$82,378	$81,440	$110,165	$65,250	$339,233	9,233

1 Includes picnic and camp units accessible only by boat.
2 Designated beach only. Informal beach use throughout.
3 Includes 3600 acres of existing State Recreation Area.

Wildlife Preservation and Management Areas

Only small remnants of the historic Delta tidal marsh remain today. Most of these remnants take the form of non-leveed channel islands which are scattered throughout many of the Delta waterways. These unreclaimed islands are also called "tule berms" and "waste islands". They always support dense plant growth as long as they are not molested by man. These islands and their dense vegetation provide the highest quality of nesting, roosting and escape cover in the Delta for many species of wildlife including game birds, perching birds, wading birds, marsh birds, birds of prey and water-associated fur bearers. The most scenic areas of the Delta are those meandering waterways that contain an abundance of non-leveed channel islands.

Natural Areas

Truly natural areas in the Delta are rare since man has altered most of the channels by dredging material from the bottom and piling it upon the adjacent banks to form levees. The term "natural" as used here is a relative measure of wilderness that a waterway area possesses when compared to other areas. This "natural" aspect is present if the waterway has a meandering course, and there is an

abundance of wild vegetation in the form of trees, shrubs, weeds, grasses, vines and emergent aquatic plants on: 1) the waterward side of the levees, 2) waterward berms, and 3) non-leveed islands in the channel or, 4) any combination of these three.

Natural areas provide the necessary denning, nesting, roosting and escape cover essential to a multitude of wildlife species. The overhanging boughs of trees and shrubs and the tidal-washed vegetation on islands, berms and marshes provide a continuing supply of decomposing plant material called detritus. Detritus is one of the major "first" links of a food chain for fish and other aquatic life. A "natural" area in the Delta, therefore, is usually endowed with a rich fish and wildlife resource or at least the potential for such a resource. Combine the aesthetic beauties of a meandering, tree-lined waterway with an abundance of fish and wildlife and you have the environmental serenity necessary to sooth the frustrations of man and beast. To preserve this atmosphere of serenity, it is essential that man restrict his activity in such an area to passive rather than to active forms of recreation. These may include such activities as hiking, wildlife observation, slow boat cruising, and fishing. Besides passive recreational use, natural areas provide ideal locations for historical and biological studies.

Groups of non-leveed channel islands in specific reaches of Delta waterways and certain other islands of special individual value must be preserved if their scenic beauty and wildlife resources are to be passed on to future generations. Individual islands of special interest are: 1) the island in the South Fork Mokelumne River just north of Sycamore Slough. This island is a nesting and roosting area for black-crowned night herons. 2) Brown's Island, near Pittsburg. This is one of California's largest heronries. The only other heronry of comparable size is the San Luis Island heronry in the San Joaquin Valley. A 1963 survey listed 600 herons of four species with approximately 200 active nests on Brown's Island.

Recommendations

The following lands should be acquired for public ownership and designated as "Natural Areas". They should be managed for the preservation of fish, wildlife, and an atmosphere of serenity and scenic beauty. Where the Department of Fish and Game is recommended as the managing agency, operation and maintenance would consist of the necessary posting and patrol. Natural areas are shown on Plate 2 and designated as "Fish and Wildlife Areas".

1. All of the channel islands and adjacent levees in that portion of Old River bounded by Coney and Union Islands. These should be managed by the Department of Fish and Game.

2. All of the channel islands and adjacent levees in Latham Slough (east of Mildred Island). These should be managed by the Department of Fish and Game.
3. The unnamed island in the South Fork Mokelumne River just north of Sycamore Slough. This should be managed by the Department of Fish and Game.
4. All of the channel islands, adjacent levees, and marshes in Lindsey Slough. This could be a possible feature of the proposed North Bay Aqueduct.
5. Brown's Island, near Pittsburg. Preferably, the entire island should be designated as a heron sanctuary, and proposed legislation to give state protection to the area should be prepared by the California Department of Fish and Game. If, in time, other recreational uses are deemed compatible and necessary, human use of the island should be rigidly confined to the western half of the island, thus preserving the eastern half as an inviolate heron sanctuary.

Protected Use Areas

Several areas in the Delta possess the environmental characteristics that are necessary for the provision of extended periods of visitor recreation activity. These characteristics include such desirable features as: 1) protected anchorage against wind and waves, 2) rendezvous area for boat camping, and 3) riparian vegetation that provides excellent wildlife habitat and scenic values. Such locations should be designated as "protected use areas". These "protected use areas" will provide a zone of compromised values, uses, and development between the undeveloped Delta wilderness as represented by the "natural areas" and the more completely developed "intensive use areas".

Recommendations

Protected use areas should be controlled and operated as public or private recreation and park units in such a manner as to permanently preserve most of the environmental characteristics of the areas. These areas should include the water and all levees, water-side berms and channel islands as described. Protected use areas are shown on Plate 2 under the classification "Fish and Wildlife Areas". The following are recommended as protected use areas:

1. That portion of the South Fork Mokelumne River between Terminous and New Hope Landing
2. Hog Slough

3. Sycamore Slough
4. Disappointment Slough between Honker Cut and Shima Tract
5. Potato Slough
6. Nearly all of the non-leveed channel islands in the San Joaquin River, Old River and Middle River.

State Wildlife Management Areas

The only state owned and operated wildlife management area in the Delta is Lower Sherman Island. This island, located at the forks of the Sacramento and San Joaquin Rivers, was an approximately 3,200 acre leveed agricultural tract until the early 1900's when the levees broke and it was flooded. Lower Sherman Island is now state owned and operated by the Department of Fish and Game as a non-intensive wildlife management area. "Non-intensive" as used here means that the area is allowed to remain in as natural a condition as possible. The intensive environmental controls such as employed on most state waterfowl management areas and federal waterfowl refuges are not employed at Lower Sherman Island. Approximately one-half of the island's surface is flooded. Through numerous levee breaks, this flooded area is connected to the adjacent navigable waterways providing public access by boat. The main body of water in the flooded area, which is called Sherman Lake, provides

a semi-wind protected water area that is heavily used by recreationists for water skiing in the summer, waterfowl hunting in the fall and winter, and boat cruising, fishing, and wildlife observation in all seasons. The land area of Lower Sherman Island is composed of the remnants of the original levee system, a tidal marsh and some spoil deposition sand dunes built by adjacent channel dredging. These areas and their wild vegetation support good populations of waterfowl, shore birds, marsh birds and cottontail rabbits. The intertidal zone supports an abundance of crayfish. These crayfish are an important food item of fish, birds and furbearing mammals. The abundance of crayfish shells under the trees of the nearby Brown's Island Heronry is an indication of the importance of this food resource to the hundreds of herons and egrets that nest and roost there.

The present recreational use of Lower Sherman Island is heavy. There is a rapidly increasing demand and need for similar recreational facilities. There is the immediate necessity of preserving fish and wildlife habitat. Also, there is a need for a demonstration area for the integration of agricultural practices and wildlife habitat. Therefore, additional state wildlife management areas are needed in the Delta.

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Recommendations

Three areas are recommended for ownership in fee by the State as wildlife management areas to be developed and managed by the Department of Fish and Game. Wildlife Management areas are delineated on Plate 2 and designated "Fish and Wildlife Areas". These three areas are:

1. Big Break - this is a flooded island similar to Lower Sherman Island except that the only exposed land is the remnants of the levee system. Sedimentation has made the water shallow and future spoil deposition will hasten the land building process. Thus, the area is progressing towards a tidal marsh similar to Lower Sherman Island. This area should be operated as a non-intensive wildlife management area.
2. A suitable area should be selected in the Delta of approximately 1,000 acres to serve as a public hunting area and a demonstration area for the coordination of agricultural practices with wildlife habitat. As a compatible use, this area should be made available to the University of California for the operation of an experiment station testing peat soil subsidence control and land building techniques.

3. Paradise Cut - this is a flood water by-pass between the San Joaquin River and Old River. It lies along the south side of Stewart Tract. There are approximately 850 acres of floodway unleveed lands and channels. Some of the lands have been cleared of wild vegetation and are farmed. This area should be operated as a non-intensive wildlife management area.

Other Areas

There are a multitude of undeveloped non-leveed channel islands scattered throughout the Delta's waterways that are not included in specific recommendations for 1) state parks, 2) natural areas, 3) protected areas, or 4) wildlife management areas. These channel islands and their growths of wild vegetation provide important wildlife habitat, a source of detritus for the food chain and much of the existing Delta waterway beauty.

Recommendations

All of the undeveloped, non-leveed channel islands not included in other specific recommendations should be considered for public ownership for the preservation of their abundant wildlife, scenic and recreational values.

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Wildlife and Recreation as a Delta Farm Crop

Fish and game are produced and harvested as a farm crop in many parts of the country. This resource is either part of the landowner's rotation crops or the principle land product, with limited livestock grazing or grain production as secondary crops.

In many parts of the Delta area, wildlife farming and recreational pursuits can become a principle and profitable land use. Many of the islands are subsiding at such a rapid rate, it is becoming difficult to carry on intensified farming practices. With increasing subsidence, levee and land maintenance costs for row crops go up. Rising labor and machine costs also cut into the farmer's profits.

Land Subsidence - A Deleterious Condition

Researchers predict dire results unless steps are taken to reduce or halt the subsidence. John Thompson[1] stated "Dissipation of the organic matter is an especially serious situation because the parent material, peat, is a nonregenerative resource. Assuming no public aid, it is conceivable that the exhausting peat will cause land to subside to the point where drainage and levee maintenance cost will make continued operations impractical.

[1] John Thompson, December, 1957. The Settlement Geography of the Sacramento-San Joaquin Delta, California. A dissertation for the degree of Doctor of Philosophy in Geography - U of C - microfilm.

"New reclamations could be drained by gravity almost immediately after levee breaks; the present below sea level basins must be pumped out. Such costs and the expense of restoring levees and land improvements have prevented the recovery of Frank's Tract from its 1938 flooding."

Researcher Walter Weir[2] of the University of California found the subsidence rate of deep peat soils to be about three inches per year, with no indication that the rate is decreasing.

Oxidation and burning are two major factors causing the peat to subside. Burning of peat lands, for whatever purpose, is one of the most destructive practices in this area.

F. E. Broadbent[3], following Weir's studies, recommends as a means of conserving these soils, that consideration be given to management for pasture. This would maintain the soil in an undisturbed condition with a high water table, and an extensive fibrous root system would contribute substantially to the organic matter of the soil. At a time of surplus food, Delta lands probably

[2] Walter W. Weir, June, 1950. Subsidence of peat lands of the Sacramento-San Joaquin Delta, California - Hilgardia, Vol. 20, No. 3, U of C.

[3] F. E. Broadbent, February, 1960. Factors Influencing the Decomposition of Organic Soils of the California Delta - Hilgardia, Vol. 29, No. 13 - U of C.

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should be taken out of intense agricultural production and preserved. The land could be reclaimed at a later date when food is not in surplus. Preserving the land in a condition of year-round wildlife habitat would help to arrest subsidence. Experiments in land building could also be tried.

In an interview with Allan Carlton, University of California Coordinator of Peat Soil Conservation and Dust Abatement, he expressed concern that unless an active program is developed to halt subsidence, lowlands will eventually be inundated. The University of California is making detailed soil subsidence studies. The establishment of a University Field Station on peat lands would benefit the program. Detailed investigations of the abatement of peat soil subsidence and techniques of soil building could best be done on state owned land where the continuity of land management practices could be assured. The establishment of such an experiment station on one of the wildlife management areas recommended by the Delta Master Recreation Plan might well be a compatible multiple use for the preservation of Delta resources.

As land subsidence increases and the water table rises, it becomes more economical to produce wildlife crops than row crops. Eventually, wildlife and recreation can be expected to equal or exceed agricultural crops.

Land subsidence can be retarded by planting alfalfa, permanent pastures and other less intensified crops. The development of wildlife habitat and establishment of a recreation preserve will not only benefit the land, but bring a profit to the owner as well.

Wildlife Recreation and Agriculture

The Delta area is ideally located for production of fish and game. Pheasants, doves, quail, geese, ducks, frogs, striped bass, catfish, black bass, crappie, sunfish, shad and sturgeon are found wherever their proper habitat conditions exist. The region is close to densely-populated urban areas. People seeking and demanding outdoor recreation are familiar with the many water channels and highways that criss-cross the Delta.

The hunter, fisherman and outdoor enthusiast is willing to pay for his recreation. On licensed pheasant clubs, hunters will pay from $240 to $300 for a forty-bird membership. Waterfowl shooters will pay $300 to $400 a season for double duck blinds. Fishermen and nature enthusiasts are willing to pay $.50 to $2.00 daily user fees for access to fishing and picnic areas.

It is understandable that a Delta landowner may resist the thoughts of opening his land to hunters and other recreation-seeking people as he may have had bad experience

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with a few irresponsible recreationists in the past. Managing pheasants, ducks and fish as a farm crop may have not occurred to him before. Surely, he felt a little uneasy as he tried a new crop such as tomatoes or safflower for the first time. By seeking information from his farm advisor, soil conservationist and neighbors, he learned the method to raise such crops.

In a similar manner, through available technical assistance and sound management, he can also produce wildlife and develop part or all of his land into a paying recreation area.

Land owners and farmers can receive technical assistance from various public and private agencies such as: California Department of Fish and Game, U. S. Soil Conservation Service, University of California Agriculture Extension Service, County Farm Advisors, Sporting Arms and Ammunition Manufacturer's Institute, Olin Mathieson Chemical Corporation and private wildlife consultants.

Farm and wildlife recreation plans can begin by integrating licensed pheasant clubs and/or waterfowl shooting grounds with other field crops or simply maintaining or enhancing wildlife habitat on poorer soils on the farm. As experience is gained, land areas can be developed into complete year-round multiple use recreation areas.

Details of private land operation for fish and wildlife-oriented recreation will be found in the Appendix of this report entitled "Sacramento-San Joaquin Delta Master Recreation Plan - Fish and Wildlife Aspects".

Recommendations

The Department of Fish and Game should accelerate their cooperative programs with other state and federal agencies to provide landowners with technical assistance for the development of wildlife habitat and outdoor recreation on private land. Greater effort should be made to encourage Delta landowners to develop an outdoor recreational program on their lands.

This segment of the Delta Master Recreation Plan urging landowners to develop wildlife habitat and outdoor recreation should be published as a separate and detailed bulletin for public distribution.

Access for Fish and Wildlife Oriented Recreation

In order to use and enjoy fish and wildlife, people must be able to get to these resources. When California became a State in 1850, Californians had legal access to all of the undeveloped Delta lowlands and all of the tidal waters. Since there was very little reclamation of the Delta lowlands until the 1860"s, Californians enjoyed the ultimate in public access in the Delta for a

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few years. This was the result of the common law that upon a state's admission into the Union, the state acquires title to the navigable waters within its territory, and to the land underlying such water up to ordinary high water mark (California Civil Code, Section 670 provides in part: "the State is the owner of all land below tide water, and below ordinary high water mark, bordering upon tide water within the State; ...").

During the 1860's, 1870's, and 1880's, the Delta lowlands became private land. Not only was public access to the tidal marsh lands eliminated by reclamation levees, but also a multitude of tidal sloughs were closed off.

Present Waterway Access

With a few exceptions, the tidal navigable waterways of the Delta are well defined. This remaining network of navigable waterways has preserved a degree of public access not usually found in areas of intensive row crop agriculture.

Present Road Access

The public road network in the Delta has done little to enhance fish and wildlife-oriented recreation. These roads, like the levees are a shining example of single purpose design.

The Delta, with its fauna, flora, and unique topography, is rich in scenic value, yet there are few places

for cars to stop along the public roads. Those stopping places that exist appear to be there by accident. The public can drive mile after mile on public roads that parallel public waterways, yet they are trespassing on private land if they attempt to cross the 50 foot strip separating these two public rights-of-way. There are many public bridges in the Delta where public roads cross public waterways, yet there are no provisions for parking or for any interchange between these two rights-of-way.

Recommendations

The public road system should include parking facilities at strategic locations and provide interchanges between the public roads and public waterways where these two rights-of-way cross.

The Department of Fish and Game should actively participate with the Department of Parks and Recreation in its development of a staged plan for auto and aquatic parkways.

Bank Fishing

Bank fishing is a popular form of Delta recreation. It supplies a very sizable amount of food for the table as well as the sport recreation in the form of white catfish, striped bass, black bass, various sunfishes, shad and an occasional sturgeon. Bank fishing is the last major form

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of recreation in the Delta that is done mostly on a trespass basis. The bulk of the bank fishing areas that are now used by the public could be closed legally if the landowners or the Reclamation Districts so desired. Without provisions for legal access to levee banks, the future of bank fishing in the Delta is doomed to be restricted to a few over-crowded public lands. The problems that create this unfortunate situation are the ever-increasing demand for more bank fishing, the increasing litter, the lack of parking facilities and levee erosion from trampling created by bank fishermen.

Recommendations

Levees that are recommended for public ownership by the Delta Master Recreation Plan should include access for bank fishing and other recreational activities connected with the public waters. Such access need not necessarily be open to the motoring public if such use would either degrade the levee as a flood control structure or impair the use of the levees or berms as recreational and wildlife habitat areas. Foot access or boat access by the public as indicated will, in many instances, better serve the multiple use concept of a particular section than would car access. In any event, some type of public access should be made available on all possible lands adjacent to the waterways.

Boat Launching Access

Many of the Delta waterways have commercial boat launching facilities at reasonable rates. A few public boat launching facilities exist. These public facilities are Wildlife Conservation Board facilities operated by local governmental agencies at Clarksburg, Rio Vista and Stockton, and State Division of Beaches and Parks facilities at Brannon Island State Park. The great number of boat owners impatiently waiting to launch or load their boats at the various facilities during the spring, summer and fall attests to the need for additional launching facilities.

Once in the water, the larger and faster boats are able to travel long distances to reach favorite fishing or wildlife observation grounds. The owners of low horse-power smaller boats are denied access to much of the good fishing waters or scenic areas of the Delta simply because of the long distances between access facilities.

Recommendations

1. Encourage development of commercial boat launching facilities for trailer borne or large boats in areas compatible with land and water use recommended by the Delta Master Recreation Plan.

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2. In areas where private enterprise does not meet the demand, federal, state and local agencies should fulfill the need for additional launching facilities.
3. Governmental agencies should provide parking and walking facilities to allow recreationists with car-top boats to get to the smaller, more wind-protected public waters..

Hunting

Prior to World War II there was enough unposted pheasant habitat to handle the pheasant hunters of California. Good waterfowl hunting areas were more difficult for the unattached hunter to find; however, there were many areas of medium quality waterfowl hunting available on private land just for the asking.

A sudden reversal of this situation occurred soon after the war. This was the result of California's rapid population increase and a tremendous increase in the number of sportsmen. The growing army of sportsmen with more leisure time became somewhat of a general nuisance to many farmers. Additional hunting pressure was created on the remaining open land as more and more land was posted and closed to the public.

To fulfill the needs of both farmers and sportsmen, controlled hunting systems were tried by both state and private interests. The cooperative hunting area program was started in 1949 by the Department of Fish and Game to provide pheasant hunting on private land. In the same year, the first community hunting area was operated by local interest. Licensed game bird clubs, or licensed pheasant clubs as they are now called, began in 1939 in California as a private enterprise operation.

State Cooperative Hunting Areas

In the Sacramento-San Joaquin Delta, one state cooperative pheasant hunting area was operated in 1949 (the first year of legislative enactment of regulations providing for cooperative hunting operations). The next year, 1950, two co-ops were operated and their numbers increased until 1953 when seven co-ops were operated. A decline in co-op numbers began in 1956 when six were operated in the Delta. This decline has continued with the 1965 season's operation including only three Delta co-ops.

The co-op program was highly popular with pheasant hunters and landowners in its early years. The success of the program, as far as landowner acceptance, was principally based on three aspects: 1) Department of Fish and Game control of the number of hunters using a given area; 2) closed zones to protect standing crops, livestock, and buildings; and

3) a restricted zone feature which allows the farmer and his friends to have a portion of his lands for their own undisturbed hunting.

This program, and its attendant law enforcement, has gone a long way in solving the trespass problems of the Delta landowners by gradually changing the historic public concept that trespass hunting was morally acceptable, even though illegal. In the beginning, co-ops were attractive to landowners because they solved their trespass problems. As these problems diminished, landowners became more reluctant to participate, which accounts in part for the present decline in the number of co-ops.

Community Pheasant Hunting Areas

Community pheasant hunting areas have never been tried in the Delta. This program could supply a vast amount of pheasant hunting recreation in the Delta. It would compete directly with the co-op hunting program offered by the Department of Fish and Game just as it has in the Sacramento Valley. This may be desirable if the number of co-ops continues to decline and as long as the seasonal permits continue at the present reasonable rates of $7.50 to $10.00 per hunter, per season.

Licensed Pheasant Hunting Clubs

There has been a steady increase in the number of licensed pheasant clubs in the Delta just as there has been

in the rest of the State. During the 1964-65 licensed pheasant club season, twenty-two of these clubs were in operation in the Delta. They provide an exclusive type of recreational hunting for a limited number of hunters per acre.

Duck Clubs

During the 1964-65 waterfowl season, a known minimum of 159 private duck clubs were in operation on approximately 12,000 acres in the Delta. Other than the public waterways which supply a relatively poor grade of pass and decoy shooting, the public is limited to the state-owned Lower Sherman Island for waterfowl hunting in the Delta. There is a real need for public waterfowl hunting areas in the Delta. The proposed 6,000 acre (approximately) national wildlife management area in the Yolo By-pass is a recommended feature of the Bureau of Reclamation's Sacramento River Division - West Sacramento Canal Project. As proposed, this federal area would provide some of the needed waterfowl hunting recreation for the public.

Recommendations

1. The Department of Fish and Game should review and analyze the co-op program in the Delta in light of present and future needs of the landowners and the sportsmen.

2. Controlled hunting can and should be expanded in the Delta on the three proposed wildlife management areas, and on private land through pheasant hunting co-ops or similar programs.

Several major Delta water resources and related projects are now in the planning stages. Each of these projects can materially benefit the Delta's recreational resource. The recommendations that follow are made with that objective.

The waterway use plan presented in Chapter III should be conceptually followed in any future water resources or related development programs. Extensive recommendations concerning levee construction and maintenance are made in Chapter IV and these recommendations should be adhered to wherever applicable.

Peripheral Canal and Clifton Court Forebay

The State Department of Water Resources has adopted the Peripheral Canal concept to serve as the Delta Facility of the State Water Project. The U.S. Bureau of Reclamation is seeking federal authorization in order to participate in the design and construction of the Peripheral Canal. Thus, the Peripheral Canal will become a joint federal-State project serving both the State Water Project and the Central Valley Project. At the present time, a joint federal-State alignment task force is studying various alternatives for canal alignment.

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Clifton Court Tract will be converted into a forebay reservoir to smooth out fluctuations in pumping at the State's Delta Pumping Plant. Supplemental storage outside the canal will be needed in order to make offpeak pumping at the Delta Pumping Plant feasible. The Clifton Court Forebay will be constructed and operated by the State.

The Peripheral Canal will be hydraulically isolated from the Delta. This unlined canal will extend from the Sacramento River near the town of Hood and skirt the Delta's eastern edge past Stockton to the State and federal export pumping plants near Tracy.

Fresh water releases to be made into Delta channels will repel salinity, protect and enhance the fishery, and provide water quality control for local water supply.

The canal will be approximately 43 miles in length and will have a width in excess of 400 feet. The Peripheral Canal's capacity at its intake will be about 21,800 second-feet, 10,300 second-feet of which will meet the State export demands. Environmental control release facilities to the Delta channels will have a combined capacity of 5,400 second-feet.

At its southern extremity the canal will divide into two branches. The south branch will proceed to the Bureau of Reclamation's Tracy Pumping Plant and the west branch will terminate at the Clifton Court Forebay of the State's Delta Pumping Plant.

The State's Delta Pumping Plant is scheduled to begin operation, to a limited extent, in 1967 with minimal diversions across the Delta. The Peripheral Canal will be ready for operation in 1974.

The State has the authority and technical capability to design, construct, operate, and maintain the Peripheral Canal. However, in the interest of furthering a joint venture, the State has tentatively agreed that the U.S. Bureau of Reclamation will design and construct the project.

Following construction, the State has proposed that the Peripheral Canal be physically operated and maintained by the State. The federal-State San Luis Project, to be operated by the State after construction by the Bureau, establishes a precedent supporting this position.

Operation and maintenance of the canal will include operating and maintaining the headworks, the fish facilities for preventing migrant fish from entering the canal and the pumping plant, the environmental control structures along the route of the canal for controling water releases into Delta channels, and will also include monitoring water levels and flows in the canal, as well as monitoring water quality in the Delta. Operation and maintenance of the several recreation areas proposed along the canal route, and patrolling and maintaining the canal and its banks will also be an important function.

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Preservation and enhancement of the Delta fish and wildlife were prime considerations in selecting the Peripheral Canal over the other plans. Management of fish and wildlife resources is a prerogative of the State of California.

While the Peripheral Canal provides the opportunity for protection and enhancement of the Delta fishery, it must be operated in a manner to provide a suitable Delta environment if such opportunity is to become a reality.

The State has already invested more than $1 million in biological and engineering studies in order to learn what environmental requirements are needed, and these investigations are continuing. These investigations will be further continued with periods of testing when the Peripheral Canal begins operating, and modifications and adjustments will be made as necessary.

Opportunity for Recreation Development

Development of one of the State's most important resources and the physical opportunity for satisfying recreation demands in the Delta will become available with the construction of the proposed Peripheral Canal and Clifton Court Forebay. A total of about 5,000 acres of new water surface will become available.

One of the important benefits to recreation will be the opportunity for relieving the Delta's critical recreation shortages of access, parking and beaches. In addition to providing the opportunity for relieving critical and other

recreational shortages, a whole array of new recreational opportunities will become available, such as swimming, fishing, picnicking, water skiing, boating, camping and riding and hiking.

Initial recreation demand after construction of the proposed Peripheral Canal is estimated to be about 1.25 to 2 million visitor-days per year. This estimate is based on the expected increase in recreation demand from 1963 to 1974. Initial facilities should be developed to meet this demand.

Recreation use at the Clifton Court Forebay was estimated partly on the basis of the proposed facilities to be installed and partly by the expected useful length of the recreation season. Initial developments should provide for 700,000 visitor-days to meet the expected demands.

Even though a program of access, parking, and beach construction throughout the Delta were to be started immediately, the increasing recreation demand will remain far ahead of any reasonable development programs. Therefore, immediate use can be expected of any of these facilities to be installed at the Peripheral Canal and Clifton Court Forebay.

In developing a concept for recreation development for the Peripheral Canal, it was necessary to examine the capacity of the canal and its right-of-way to support the expected recreation demand. It is apparent that the

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canal, alone, will not support the expected demand.

To provide the additional recreation development necessary to meet the expected demand, a concept of cluster or node development of facilities appears to be most favorable. Under the cluster concept, on-canal recreation areas and off-canal recreation areas at natural slough or river crossings could be developed to provide facilities for swimming, fishing, picnicking, water skiing, boating and camping. Water access into the canal via boat locks could be included if economically justified, and if compatible with other purposes of the canal.

Location of initial clusters should be selected on the basis of access from both land and water, proximity to population centers, existing vegetative cover and areas of heavy recreation use where facilities are lacking. As recreation use increases, cluster size could be increased and additional clusters could be developed.

In addition to the development of centralized recreation areas, a system of trails and facilities for hiking, bicycling, horseback riding and incidental day-use could be developed along the canal. At the northern end, such a system would connect with the trail system contemplated by the County of Sacramento, along the Cosumnes, Sacramento and American Rivers. At the southern end, the system would connect with the trails to be installed along the California Aqueduct and the eastern edge of the trail system contemplated by Contra Costa County. All of the trail systems proposed in the State Park System recommendations of Chapter VI could be linked by a Peripheral Canal trail.

The proposed Clifton Court Forebay will provide a great opportunity for development of beach areas and facilities for swimming, picnicking, boating and water skiing.

Recommendations

It is recommended that advanced planning, design and construction of the Peripheral Canal and related facilities give adequate consideration of the foregoing conclusions.

Recreational facilities should be operational at the time the project goes into operation and initial recreational facilities should be adequate to accommodate the expected use during the first ten years of project operation.

Since it has been proposed the Peripheral Canal will be a federal-State joint-use facility, probably constructed by the Federal Government and operated and maintained by the State, State law and policies regarding recreation cannot be directly applied. The State Departments of Water Resources, Parks and Recreation and Fish and Game should continue to make every effort in seeing that facilities developed for the project will meet the expected demand in a manner satisfactory to the State's interests.

Since it has been proposed the Clifton Court Forebay should be constructed as a State-only facility,

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planning for recreation, along the recommendations set forth in this report, should be carried out jointly by the State Departments of Water Resources and Parks and Recreation forthwith and according to the provisions of the Davis-Dolwig Act.

It is further recommended that a recreation committee be appointed to assist the State and Federal Governments in carrying out advanced planning studies and to assist in developing design and operating concepts. This sub-committee should include, but not be limited to, representatives from Federal, State and local governmental organizations having interests in recreation and fish and wildlife.

Sacramento Deep Water Ship Channel and Stockton Deep Water Ship Channel

The U.S. Army Corps of Engineers have completed the Sacramento deep water channel and propose to dredge and shorten the Stockton deep water channel via the False River cut-off. The banks of the Sacramento deep water channel offer an excellent opportunity for a beautification program, for public access for bank fishing and upland game hunting and for the development of wildlife habitat. As it now exists, this new navigation channel is a huge ditch that is bleak and uninspiring. It lacks public access and is almost devoid of recreational opportunity although considerable potential exists all along its many miles of banks. The Sacramento-Yolo Port District and the Corps of Engineers should jointly re-examine the recreational potential of this ship channel.

The Stockton deep water ship channel also presents an opportunity for considerable recreation enhancement. This has been recognized by the Corps and much of the recreation potential of the project has been incorporated into the project design in their report titled "Review Report on Navigation - San Francisco Bay to Stockton, California, Appendix D - Recreation, September 1963". The details of their landscaping plans will provide the opportunity for the preservation and enhancement of scenic beauty and wildlife habitat.

The False River Cut-off portion of the proposed Stockton ship channel offers an ideal opportunity for combined State-federal participation of the Frank's Tract State Recreation Area as noted in Chapter VI of this report.

Recommendations

It is recommended that these projects give full consideration to existing scenic and wildlife resources and that these resources be protected and/or restored, if lost due to project construction, and that public access be provided to these projects.

The Department of Parks and Recreation and the U.S. Army Corps of Engineers should coordinate their studies so that realignment of the False River Cut-off can permit implementation of both the State's and Corps' proposed projects.

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The proposals for recreation development proposed by the Corps in the Army's report on navigation as noted above have been considered in formulating this master plan and are endorsed and recommended in concept.

Future Flood Control Projects

The U.S. Army Corps of Engineers if presently conducting an investigation to determine feasibility of providing flood control works in the Delta. Such a project would involve levee rehabilitation on levees now classified as non-project levees.

The Corps is considering the recreational and wildlife opportunities associated with the concept being developed. Opportunities exist for incorporating recreation into such a project and the creation of any new recreation areas should be consistent with the waterway use plan presented in Chapter III of this report.

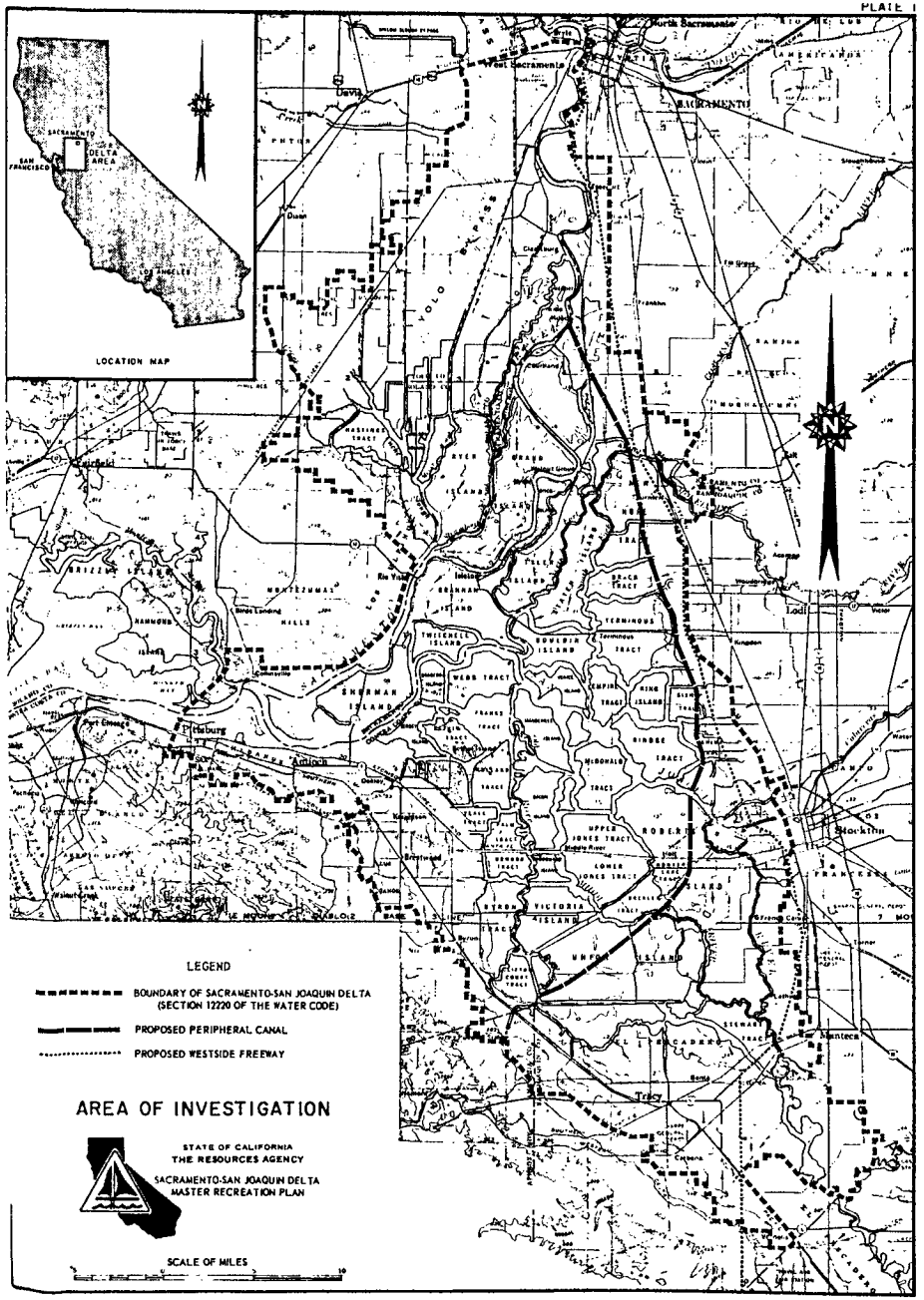
Recommendations for new levee construction and maintenance practices are made in Chapter IV and these concepts should be thoroughly evaluated and considered prior to final formulation of future flood control projects.

Future flood control projects must give full consideration to existing scenic and wildlife resources and these resources must be protected. In the event these resources are lost due to construction of future projects, then provision should be made for restoring these resources.

Recommendations

The State of California should work closely with the Corps in formulating a future flood control project. Considerations should be made relative to wildlife needs and preservation, location and magnitude of recreational facilities and levee maintenance and right-of-way requirements.

PLATE 1



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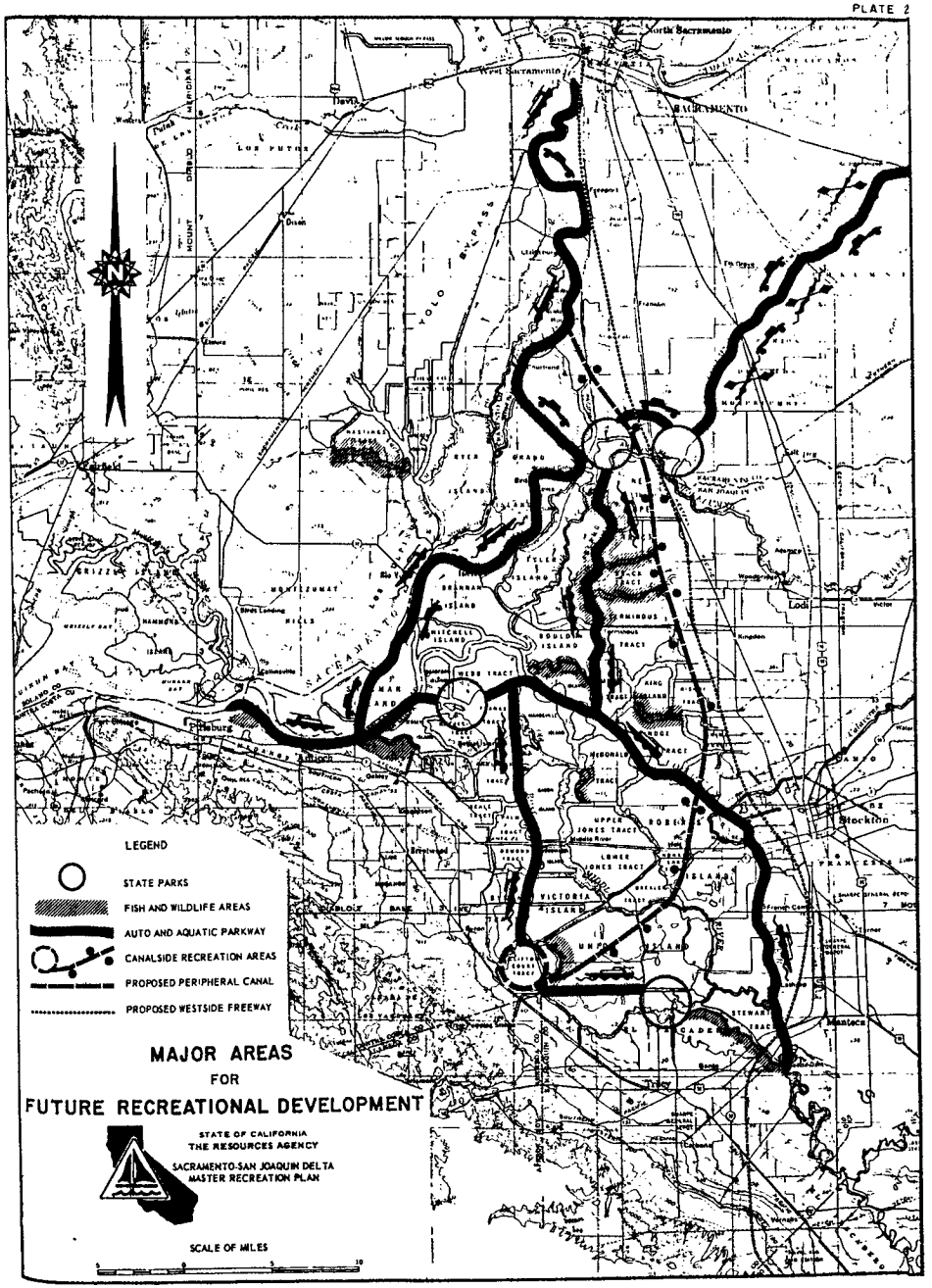

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PLATE 3

PLATE 4

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